Bermello Ajamil & Partners, Inc.

Architecture
Engineering
Planning
Interior Design
Landscape Architecture
Public Information

August 30, 2013

Mr. Kerrith Fiddler
Asst. Public Works Director
Public Works Department
City of North Miami
1855 N.E. 142 Street
North Miami, Florida

**RE: North Bayshore Park Pedestrain Walkway**

Dear Mr. Fiddler,

B&A has completed the engineering evaluations of the pier substructure for the remnant pedestrian walkway. The services were performed in accordance with our proposal, PO No. 262978, dated March 4, 2013.

A summary of our findings and recommendations for the existing foundations of the remnant pedestrian walkway is provided in the Summary and Recommendation section of this report. The results of the survey, geotechnical investigation and testing, and engineering evaluations, are to be found in the accompanying report.

We appreciate the opportunity to work for the City on this project. Please do not hesitate to contact the undersigned if you have any questions about the report or if you need additional information.

Yours truly,

**Bermello Ajamil & Partners, Inc.**

Francisco J. Tejidor 8/30/13

Francisco J. Tejidor, P.E.
Sr. Project Manager
Florida License No. 38847

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## 1.0 INTRODUCTION

The North Bayshore Park Pedestrian Walkway had an estimated length of 450 ft. The walkway was supported on a series of 33 intermediate concrete bents and two terminal platforms foundations. The intermediate bents and the terminal platform foundations are founded on 12 in. square precast, prestressed concrete piles with an overlying concrete cap beam. The superstructure of the walkway, the deck and its handrails, had been destroyed by storm action and has been completely removed. It is the City's intent to reconstruct the walkway on the exiting substructure.

## 2.0 PURPOSE AND SCOPE OF STUDY

The purpose of this study was to visually inspect, document the location of the substructure elements by field survey, perform geotechnical investigations and testing, and evaluate the available axial and lateral capacity of the existing intermediate and terminal bents by engineering analysis.

The services were performed in three phases, the Investigation Phase, Engineering Phase, and the Document Phase.

The Investigation Phase consisted of a visual inspection of all accessible intermediate bents and piles. All of the intermediate and terminal bents were surveyed to determine their exact location and elevation. A representative set of five bents were identified for geotechnical testing. The geotechnical on-site testing consisted of five Pile integrity Testing (PIT) tests and one boring. The purpose of the boring was to identify the subsurface soil/rock condition and to facilitate the calibration of the results of the PIT readings. The purpose of the PIT testing was to determine the length of the existing piles and their embedment, and detect any potential defects or damage to the piles below surface.

Upon completion of the Investigation Phase and with an estimate of the pile length and embedment as a result of the boring and PIT testing, an assessment of the axial and lateral load capacity of the existing piles was made.

This report includes the survey, geotechnical testing and results, and the engineering evaluations. Recommendations are provided regarding the available axial and lateral load capacity of the existing substructure piles.

# 3.0 SURVEY

# SPECIFIC PURPOSE SURVEY

## PROPERTY ADDRESS:

2300 BROAD CAUSEWAY, NORTH MIAMI, FLORIDA
Tax Folio #06-2228-011-4500

## LEGAL DESCRIPTION:

Portion of submerged lands lying Easterly of Lots 220 through 223, Block 14 of "SANS SOUCI ESTATES", according to the plat thereof as recorded in Plat Book 50, at Page 86, Public Records of Miami-Dade County, Florida.

## SURVEYOR'S NOTES:

1) The above captioned Property was not surveyed and described based on the above Legal Description. Provided by Client.
2) This Certification is only for the lands as described. It is not a certification of Title, Zoning, Easements, or Freedom of Encumbrances. ABSTRACT NOT REVIEWED.
3) There may be additional Restrictions not shown on this survey that may be found in the Public Records of this County. Examination of ABSTRACT OF TITLE will have to be made to determine recorded instruments, if any affecting this property.
4) Accuracy:
The expected use of the land, as classified in the Minimum Technical Standards (Chapter 5J-17 FAC), is "Residential High Risk". The minimum relative distance accuracy for this type of boundary survey is 1 foot in 10,000 feet. The accuracy obtained by measurement and calculation of a closed geometric figure was found to exceed this requirement.
5) Foundations and/or footings that may cross beyond the boundary lines of the parcel herein described are not shown hereon.
6) Not valid without the signature and the original raised seal of a Florida Licensed Surveyor and Mapper. Additions or deletions to survey maps or reports by other than the signing party or parties are prohibited without written consent of the signing party or parties.
7) Contact the appropriate authority prior to any design work on the herein-described parcel for Building and Zoning information.
8) Underground utilities are not depicted hereon, contact the appropriate authority prior to any design work or construction on the property herein described. Surveyor shall be notified as to any deviation from utilities shown hereon.
9) The surveyor does not determine fence and/or wall ownership.
10) Ownership subjects to OPINION OF TITLE.
11) Type of Survey: SPECIFIC PURPOSE SURVEY.
12) The North arrow shown hereon are based record plat of "SANS SOUCI ESTATES" recorded in Plat Book 50, at Page 86, of the Public Records of Miami-Dade County, Florida.
13) All measurements shown hereon are made in accordance with the United States Standard Feet.
14) Elevations shown, if any, hereon are based on National Geodetic Vertical Datum (1929 Mean Sea Level).
15) Benchmark Used: Miami-Dade County Benchmark #N-393-R, Elevation = +9.94'
16) The express purpose of this survey is to locate improvements within the above described parcel of land for the purpose of design. This is NOT AN ACTUAL BOUNDARY SURVEY of lands described herein.
17) This SPECIFIC PURPOSE SURVEY has been prepared for the exclusive use of the entities named hereon. The Certificate does not extend to any unnamed party.

- CITY OF NORTH MIAMI

## SURVEYOR'S CERTIFICATE:

I HEREBY CERTIFY THAT: in the professional opinion of the undersigned Professional Surveyor and Mapper in the State of Florida, the following Specific Purpose Survey meets the requirements of the Minimum Technical Standards as set forth by the Florida Board of Professional Surveyors and Mappers in Chapter 5J-17, Florida Administrative Code, pursuant to Section 472.027, Florida Statutes. Copies of this Specific Purpose Survey are not valid without the signature and the original raised seal of a Florida licensed surveyor and mapper.

ROYAL POINT LAND SURVEYORS, INC.
LB No. 7282

BY: ______________________
PABLO J. ALFONSO, Professional Surveyor & Mapper No. 5880
State of Florida
Date of Survey: 08/05/2013
Date of Last Revision:

Survey Performed By:
ROYAL POINT LAND SURVEYORS, INC.
6175 NW 153rd Street - Suite 321, Miami Lakes, Florida 33014
Phone: 305-822-6062/ Fax: 305-827-9669

| NO. | DATE | DESCRIPTION | BY | APP | NO. | DATE | DESCRIPTION | BY | APP |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

RECORD OF REVISION

ROYAL POINT
LAND SURVEYORS, INC.
L.B.#7282
6175 NW 153 ST., SUITE 321, MIAMI LAKES, FL. 33014 * TEL.305-822-6062 */* 305-698-9468 FAX.305-827-9669

PREPARED FOR:
CITY OF NORTH MIAMI
NORTH SHORE PARK PEDESTRIAN WALKWAY PROJECT

TYPE OF PROJECT:
SPECIFIC PURPOSE SURVEY

DRAWN: J.G.
CHECKED: P.J.A.
SCALE: 1" = 10'
FIELD DATE: 08/05/2013
JOB NO.: RP13-506
SHEET: 1 OF 1 SHEET

# 4.0 GEOTECHNCIAL INVESTIGATION AND TESTING

# PEDESTRIAN BRIDGE FOUNDATION RETROFIT
# AT NORTH BAYSHORE PARK
# 12220 N. BAYSHORE DRIVE
# CITY OF NORTH MIAMI, FLORIDA

# REPORT OF GEOTECHNICAL SERVICES

**PREPARED FOR: BERMELLO, AJAMIL & PARTNERS, INC.**

**PREPARED BY: GEOSOL, INC.**

**AUGUST 13, 2013**

GEOSOL, Inc.

August 13, 2013

Bermello, Ajamil & Partners, Inc.
2601 South Bayshore Drive, 3rd Floor
Miami, FL 33133

Attention: Mr. Frank Tejidor. P.E.
Senior Civil Engineer

Re: Report of Geotechnical Services
Pedestrian Bridge Foundation Retrofit
at North Bayshore Park
12220 N. Bayshore Drive
City of North Miami, Florida
GEOSOL Project No. 213153

Dear Mr. Tejidor

Geosol, Inc. (GEOSOL) has performed geotechnical evaluations for the above-referenced project. The services were performed in accordance with our proposal No. P-213120 dated February 28, 2013. You provided authorization to perform our services on July 19, 2013 by means of a subcontract agreement.

A summary of our findings and recommendations for the proposed pedestrian bridge foundation retrofit is provided in the Executive Summary section of this report. The results of this exploration, together with our geotechnical recommendations, are to be found in the accompanying report.

We appreciate the opportunity to work with you on this project. Please do not hesitate to contact the undersigned if you have any questions about the report or if you need additional information.

Sincerely,

**GEOSOL, INC.**

ORACIO RICCOBONO
LICENSE
No. 49324
STATE OF FLORIDA
PROFESSIONAL ENGINEER

8/13/13

Oracio Riccobono, P.E.
Senior Geotechnical Engineer/President
Florida License No. 49324

Adnan Ismail, P.E.
Project Geotechnical Engineer
Florida License No. 76014

cc: Addressee (3)
File (1)

GEOSOL, Inc.
5795-A NW 151st Street
Miami Lakes, FL 33014
Phone (305) 828-4367; Fax (305) 828-4235
E-mail: geosolusa@bellsouth.net

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# 1.0 INTRODUCTION

## 1.1 Project Description

Based on information you provided to us on February 26, 2013, we understand that the foundation of the pedestrian bridge at North Bayshore Park requires retrofitting. As we understand the pedestrian bridge has a length of approximately 450 feet, and that the bridge's superstructure was destroyed by storm action and has been completely removed. Also, we understand that the pedestrian bridge foundation consists of numerous bent caps supported by 12-inch square prestressed concrete piles and that the City is planning to reconstruct the pedestrian bridge superstructure on the existing foundation. As we understand it, the purpose of this study is to investigate the length, integrity, and potential capacity of the existing pedestrian bridge foundations that are part of the above-referenced retrofit.

This report presents the results of our low strain integrity testing, subsurface exploration and laboratory testing as well as our geotechnical recommendations for the proposed improvements

# 2.0 PURPOSE AND SCOPE OF STUDY

The purpose of this study was to perform a subsurface investigation and low strain integrity testing for the above-referenced pedestrian bridge foundation at North Bayshore Park in order to catalog the general near-surface stratigraphy and provide recommendations for the proposed pedestrian bridge foundation retrofit.

The scope of services for the geotechnical testing program associated with the proposed streetscape improvements consisted of the following:

1. Discussing with Bermello, Ajamil and Partners, Inc. (BA) the scope of the field exploration and laboratory testing programs for this project.

2. Conducting a general visual reconnaissance of the site, locating, and coordinating with existing utilities.

3. Reviewing the USDA Soil Survey for Miami-Dade County publication for existing geotechnical data along the project vicinity.

4. Executing a program of subsurface exploration consisting of subsurface sampling and field testing. The subsurface program was accomplished by performing Standard Penetration Test (SPT) borings.

5. Visually classifying the samples from the SPT borings in the laboratory using the Unified Soil Classification System (USCS). The laboratory testing program included percent passing the No. 200 sieve, organic content determination, moisture content determination, and FDOT environmental classification testing.

6. Executing a Pile Integrity Testing (PIT) program in order to investigate the length and integrity of the pedestrian bridge foundation.

7. Providing foundation evaluation for the proposed pedestrian bridge foundation retrofit.

8. Preparing a report which summarizes the course of study pursued, the field and laboratory data generated, subsurface conditions encountered, analyses, and report limitations.

### 2.1 Report Format

This report begins with a discussion of the field and laboratory testing programs followed by general and specific subsurface conditions, geotechnical engineering evaluations and recommendations, and report limitations. The site vicinity map, boring location information, boring location plans, and report of core borings sheet are presented in Appendix "A" of this report. The laboratory test results are presented in Appendix "B". Bridge foundation capacity evaluations are presented in Appendix "C". Site photographs and Pile Integrity Testing Impact Diagrams are presented in Appendix "D"

## 3.0 FIELD EXPLORATION

### 3.1 General

In order to evaluate the subsurface conditions in the vicinity of the proposed pedestrian bridge foundation retrofit, one (1) Standard Penetration Test (SPT) boring was performed to a depth of 50 feet below the existing grades. The test was performed as close as possible to the locations of the proposed for the proposed pedestrian bridge foundation retrofit improvements considering existing utilities and equipment accessibility constraints. Additionally, Pile Integrity Testing (PIT) was performed at a total of five (5) piles located at different bents.

### 3.2 Field Test Locations

The test locations were marked in the field by a representative of GEOSOL prior to performing the field exploration utilizing standard taping procedures, existing landmarks and the plans provided by BA. Table 1 and Sheet 2 in Appendix "A" include information regarding the test locations performed for the proposed pedestrian bridge foundation retrofit improvements. The tests were performed as close as possible to the proposed pedestrian bridge foundation retrofit improvements considering constraints such as utilities and equipment accessibility.

The "as-drilled" test locations were obtained by means of a hand-held Global Positioning System (GPS) device. The latitude and longitude coordinates obtained with the GPS device were converted to northing and easting using the software "Corpscon" developed by the United States Army Corps of Engineers. The boring northing and easting coordinates should be considered approximate.

### 3.3 Standard Penetration Test (SPT) Borings

The borings were performed utilizing a Foremost-Mobile Model B-53 truck-mounted drill rig. The SPT borings were all performed with a recently calibrated automatic hammer. The borings were performed in general accordance with the American Society of Testing and Materials (ASTM) test designation D-1586 titled "Standard Practice for Penetration Test and Split-Barrel Sampling of Soils". All soil samples were classified in the field and placed in air-tight jars for transportation to our office for review by a geotechnical engineer and laboratory testing. The test boring location information is provided in Table 1 and in the Test Location Plan sheets in Appendix "A".

### 3.4 Water Level Measurements

Water level depths were obtained during the test boring operations. They are noted on the Report of Core Borings Sheet presented in Appendix "A". In relatively pervious soils/rocks, such as the near surface granular soils, the indicated water level depths are usually reliable groundwater levels. Seasonal variations, tidal conditions, variations in the water surface of the nearby canals, temperature, land-use, and recent rainfall conditions may influence the depths of the groundwater.

### 3.5 Pile Integrity Testing (PIT) Program

GEOSOL performed a low-strain Pile Integrity Testing Program. The low strain pile integrity test is currently the most widely used method of pile integrity testing. Low Strain Pile Integrity Testing, also commonly referred to as "Pulse Echo Testing", was performed in general accordance with ASTM D5882 "Standard Test Method for Low Strain Integrity Testing of Piles". Testing was accomplished using a "SIT Professional System" manufactured by Profound. The premise of this test method is to impart a low strain stress wave into a foundation element via a hand-held hammer and measure the impact event with a sensitive accelerometer coupled to the foundation element. The acceleration signal is recorded on the data acquisition computer than integrated once to obtain the velocity signal. The velocity signal is plotted as a function of depth. Reflections are generated in the velocity data from either the foundation toe, irregularities in the foundation, or changes in soil stiffness. Based on the time period between impact and toe reflection, the approximate length of the foundation element can be estimated.

During testing an accelerometer was acoustically coupled on the side of the foundation using pietoplast as a bonding agent. The pietoplast facilitates the signal transfer while dampening the resonance between the pile and accelerometer. Since in this case the pile tops were embedded in the concrete cap, an aluminum block was anchored to the side of the pile to impart the hammer impacts. The accelerometer was placed adjacent to the point of impact to measure the low strain wave propagation. Many impacts were generated and only the most reproducible signals for each foundation are stored on the field computer for post processing. Post processing consists of exponentially amplifying the signals to overcome dampening due to skin friction and emphasize the pile toe response. Filtering is also performed on the signals to eliminate high frequencies and random noise. Each pulse echo trace analyzed in this report displays the amplification and filtering used.

The pile material compression wave speed was estimated between 13,400 and 13,700 feet per second based on past experience, interpretation of velocity traces, and engineering judgment. It should be noted that variance in the estimated pile material compression wave speed can have an effect on the estimated pile length.

# 4.0 LABORATORY TESTING

## 4.1 General

Representative samples collected from the test boring locations were visually reviewed in the laboratory by a geotechnical engineer to confirm the field classifications. The samples from the roadway borings were classified using the Unified Soil Classification System (USCS) in accordance with ASTM test designation D-2488, titled "Standard Procedure for Description and Identification of Soils (Visual-Manual Procedure)" and ASTM D-2487 titled "Standard Test Method for Classification of Soils for Engineering Purposes". The classification was based on visual observations with the aids of limited laboratory testing results, which consisted of grain-size analysis, percent passing the No. 200 sieve, natural moisture content, and organic content. The tests were performed on selected samples believed to be representative of the materials encountered. Also, FDOT environmental classification testing was performed on a water sample recovered from a test boring performed along the alignment of the proposed landscape improvements. Summary of the laboratory test results are presented in Table Nos. 2 and 3 of Appendix "B".

## 4.2 Moisture Content

Laboratory moisture content test consists of the determination of the percentage of moisture contents in selected samples in general accordance with FDOT Test Designation FM1-T265 (ASTM Test Designation D-2216, titled "Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures"). Briefly, the moisture content is determined by weighing a sample of the selected material and then drying it in a warm oven. Care is taken to use a gentle heat so as not to destroy any organics. The sample is removed from the oven and reweighed. The difference of the two weights is the amount of moisture removed from the sample. The weight of the moisture divided by the weight of the dry soil sample is the percentage by weight of moisture in the sample. The moisture content test results are presented in Table No. 2 in Appendix "B".

## 4.3 Grain-Size Analysis

The grain-size analyses were conducted in general accordance with the FDOT Test Designation FM1-T88 (ASTM Test Designation D-422, titled "Particle-Size Analysis of Soils"). The grain-size analysis test measures the percentage passing the No. 200 Sieve. In this manner, the grain-size distribution of a soil is measured. The percentage by weight passing the No. 200 Sieve is the amount of silt and clay sized particles. The test results are presented in the Appendix.

### 4.4 Organic Content

Organic content test consists of the determination of the percentage of organic content in selected samples in general accordance with FDOT Test Designation FM1-T267 (ASTM Test Designation D-2974, titled "Moisture, Ash, and Organic Matter of Peat and Other Organic Soils"). Briefly, the organic content is determined by weighing a sample of the selected material and then burning off the organic material in a hot oven. The sample is removed from the oven and re-weighed. The difference of the two weights is the amount of organic material removed from the sample. The weight of the organic material divided by the weight of the dry soil sample is the percentage by weight of organic material in the sample. The organic content test results are summarized in Table No. 2 of Appendix "B".

### 4.5 Environmental Classification

GEOSOL performed environmental corrosion testing on a water sample collected from a test boring performed along the proposed streetscape improvement alignment. Environmental corrosion tests include parameters such as pH, resistivity, sulfate content and chloride content. The environmental corrosion tests were conducted in general accordance with the FDOT Test Designations FM5-550, 5 551, 5-552, and 5 553. Based on the laboratory test results and the procedures outlined in the FDOT's *Structures Design Guidelines*, Section 1.3, the environment near this project has been classified as extremely aggressive for the substructure and extremely aggressive for the superstructure. We have summarized the test results in Table 3 of Appendix "B".

## 5.0 GENERALIZED SUBSURFACE CONDITIONS

### 5.1 Miami-Dade County Regional Geology

The Miami area of southern Florida is underlain by an alternating sequence of cemented and uncemented Pleistocene sedimentary deposits (Pleistocene Epoch, deposited 10,000 to 2 million years before the present). A near surface Miami Limestone Formation is underlain by a wide variety of loose to dense quartz sands and coarse to fine-grained hard to very hard limestones and sandstones (Fort Thompson Formation). However, in many portions of Miami-Dade, surface sand deposits of the Pamlico Formation and man-made (artificial) fill are encountered. The Pamlico sands and man-made (artificial) fill have a thickness of approximately three (3) to seven (7) feet and overlie the Miami Limestone Formation. In the west part of the county, portions of the Everglades interfingers with the Pamlico sands. The Everglades soils consist of peat organic silt and calcareous silt marl. The Everglades soils also have a thickness of three (3) to seven (7) feet and overlie the Miami Limestone Formation.

Although the Miami Limestone Formation can be very porous and have a sponge-like, open interconnected network of vugs and small voids, large cavities do not exist and there is no potential for sinkhole activity. The rock formations encountered in the Miami area are typically much softer than the "bedrock" formations encountered in other areas of the country.

The strength of the limestone as well as its deformation characteristics depends upon the degree of cementation of the formation and its alteration by solutioning and weathering subsequent to deposition. One of the most important characteristics of the limestone encountered in the project area is the degree of erosion. Past surface solutioning of the limestone has resulted in formation called "pinnacle rock". In some cases nearly vertical cylindrical-shaped solution cavities are filled with surficial fine sands extending below the groundwater level. The subsurface conditions encountered at the site are presented in the following section.

### 5.2 Miami-Dade County Soil Survey

The *Soil Survey of Miami-Dade County Area, Florida*, published by the United States Department of Agriculture (USDA), was reviewed for general near-surface soil information within the general project vicinity. This information indicates that there is one (1) primary mapping unit within the project vicinity, as follows:

- Urban Land (15): consists of areas that are more than 85 percent covered by commercial space, residential space, public facilities, airports, streets, sidewalks, and other structures. The soils in open areas consist of lawns, parks, vacant lots and playgrounds. The surface soils and fill materials are underlain by the porous natural limestone formation.

## 6.0 SITE SUBSURFACE CONDITIONS

### 6.1 General

The subsurface conditions disclosed by the borings are generally consistent with the previously described regional geology. The stratification is based on visual examination of the recovered soil samples, laboratory testing and interpretation of the field boring logs by a geotechnical engineer. The boring stratification lines represent the approximate boundaries between soil types of significantly different engineering properties; however, the actual transition may be gradual. In some cases, small variations in properties not considered pertinent to our engineering evaluation may have been abbreviated for clarity. The borings present the subsurface conditions at the particular boring location and slight variations do occur among the borings. The Report of Core Borings presented in Appendix "A" provide the conditions at the particular test locations. Presented in Appendix "A" is the site vicinity map, boring location information, and Report of Core Borings, along with the soil legend and other pertinent information such as measured groundwater table levels.

### 6.2 Groundwater Conditions

Groundwater levels were measured in the completed test boring location during the drilling operations. Measurements made in the test boring location disclosed the water table to be at depths of 4.0 feet below the ground surface. It is to be noted that borings were performed during the dry season. Therefore, during the wet season the groundwater may be 12 to 18 inches higher than the levels measured.

## 7.0 EVALUATION OF PILE INTEGRITY TESTING (PIT) PROGRAM RESULTS

In general, the evaluation is based on relative changes in the velocity traces after the initial impact event. Resulting reflections in the same direction (relative increases in wave velocity) as the impact event are normally due to occurrences such as cracks, joints, decreases in cross sectional area, changes in reinforcing steel and lower quality material. Resulting reflections in the opposite direction (relative decreases in wave velocity) as the impact event are normally due to occurrences such changes in soil conditions given the known cross sectional area associated with a driven pile.

Since a data set obtained from each pile is unique, there is not a "standard" method for interpretation. Therefore, this evaluation is largely based on our experience and engineering judgment. We have performed an interpretation of the velocity reflections as discussed below.

A strong toe reflection is important in that it suggests good overall continuity of the foundation element from the top to the bottom. The depth of the toe reflection is based on an estimated material wave speed between 13,400 and 13,700 feet per second, which falls in the generally accepted limits of stress wave speed for concrete. Impact diagrams displaying the velocity signal as a function of pile length, as well as the low strain concrete compression wave speed used in analysis, are presented in Appendix "D" of this report.

Table "B" below, provides a summary of the PIT results, and suggests pile lengths ranging from approximately 18 feet to 21 feet.

**TABLE "B" – PILE INTEGRITY TESTING RESULTS SUMMARY**

| Test Location | Estimated Pile Length (ft) (1) | Batter (Y/N) | Estimated Wave Speed (ft/sec.) | Sensor Distance Above Ground (ft) | Sensor Distance Below Pile Cap (ft) |
|---|---|---|---|---|---|
| P-1 | 19.87 | N | 13,500 | 1.37 | 0.67 |
| P-2 | 19.95 | N | 13,700 | 1.08 | 0.75 |
| P-3 | 21.44 | N | 13,400 | 2.00 | 1.04 |
| P-4 | 20.35 | N | 13,700 | 2.75 | 0.75 |
| P-5 | 18.08 | N | 13,600 | 2.17 | 0.58 |

Note: 1) Estimated pile lengths are from bottom of cap to toe of pile.

## 8.0 GEOTECHNICAL PARAMETERS FOR FOUNDATION DESIGN

The geotechnical design parameters for this study were obtained on the basis of empirical relationships between the SPT "N"-values and the shear strength of the soil/rock strata. The subsequent sections provide derivation of geotechnical parameters for use in foundation design for the proposed foundation retrofit. It is to be noted that the SPT borings performed for this study were done with the use of an automatic hammer. The SPT "N"-values obtained were corrected for hammer efficiency in accordance with the recommended relationship presented in the FDOT *Soils and Foundations Handbook (2013)* ($N_{safety} = 1.24*N_{automatic}$). Hence, any reference to SPT "N"-values from test borings performed have been corrected to safety hammer N-values ($N_{safety}$) and are referenced as such in the following paragraphs only. The SPT $N_{safety}$-value was used for foundation design.

The ground surface at the boring locations was covered by either a topsoil layer. The topsoil layer was underlain by granular fill generally consisting of slightly to silty fine to medium-grained sand with variable percentages of limerock fragments. The Miami Limestone Formation encountered at the site is relatively soft and very sandy, and it was encountered below the granular fill materials. The Fort Thompson Formation Sand layer, consisting of consists of fine to medium-grained quartz sand with variable percentages of limestone and shell fragments, was encountered below the Miami Limestone Formation and intermittently in the Fort Thompson Limestone Formation. The Fort Thompson Formation Sand layers were underlain by the Fort Thompson Formation Limestone, which is typically stronger than the upper Miami limestone formation.

Table "C" on the below presents a summary of geotechnical parameters for use in foundation analyses and design.

### TABLE "C"- SUMMARY OF GEOTECHNICAL DESIGN SOIL/ROCK PARAMETERS

| GENERAL MATERIAL DESCRIPTION (USCS SYMBOL) | UNIT WEIGHT (pcf) | | FRICTION ANGLE (Degrees) | COHESION (psf) | DESIGN UNIT SKIN FRICTION (tsf) | EARTH PRESSURE COEFFICIENTS | | |
|---|---|---|---|---|---|---|---|---|
| | TOTAL | EFF. | | | | ACTIVE | PASSIVE | AT-REST |
| | $\gamma_{total}$ | $\gamma_{eff}$ | $\phi$ | C | $f_{su}$ | Ka | Kp | Ko |
| Granular Fill (SP/SP-SM/SM) | 110 | 53 | 30 | - | - | 0.34 | 2.97 | 0.5 |
| Miami Limestone Formation | 115 | 53 | 37 | - | - | 0.25 | 0.92 | 0.41 |
| Fort Thompson Formation Sand (SP/SM) | 105 | 48 | 30 | - | - | 0.34 | 2.97 | 0.5 |
| Fort Thompson Formation Limestone | 120 | 58 | 37 | - | - | 0.25 | 0.92 | 0.41 |

## 9.0 PRECAST PRESTRESSED CONCRETE DRIVEN PILES FOUNDATION CAPACITY EVALUATION

We have prepared curves of axial capacity versus tip elevation for the existing 12-inch square piles based on the results of the PIT program and the boring performed by GEOSOL. These curves were prepared using the FDOT computer program for axial loaded driven piles, "FB-Deep", which was developed based on the procedures outlined in FDOT Research Bulletin 121. SPT "N"-values obtained from the boring performed by our firm were obtained using an automatic hammer. Since the program FB-Deep uses SPT "N"-values obtained with a safety hammer, the SPT"N"-values were converted to safety hammer "N"-values using the FDOT *Soils and Foundation Handbook (2013)* correction of $N_{safety} = 1.24*N_{automatic}$. From the FB-Deep computer outputs, the estimated Allowable Pile Capacity is approximately 15 tons. The FB-Deep runs for the boring performed for this study are presented in Appendix "C" of this report.

## 10.0 REPORT LIMITATIONS

Our professional services have been performed, our findings obtained, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. This company is not responsible for the conclusions, opinions or recommendations made by others based on these data. No other warranties are expressed or implied.

The scope of the investigation was intended to evaluate the length and integrity of the existing pedestrian bridge foundations for the proposed foundation retrofit. The recommendations submitted in this report are based upon the data obtained from the test boring and Pile Integrity Testing performed at the locations indicated. If any subsoil variations become evident during the course of this project, a re-evaluation of the recommendations contained in this report will be necessary after we have had an opportunity to observe the characteristics of the conditions encountered. The applicability of the report should also be reviewed in the event significant changes occur in the design, nature or location of the proposed structure locations.

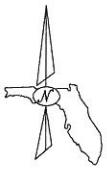
The scope of our services does not include any environmental assessment or investigation for the presence or absence of hazardous or toxic materials in the soil, groundwater, or surface water within or beyond the site studied. Any statements in this report regarding odors, staining of soils, or other unusual conditions observed are strictly for the information of our client.

**APPENDIX "A"**

Sheet 1 – Site Vicinity Map
Table 1 - Summary of Test Locations
Sheet 2 – Boring Location Plan
Sheet 3 – Report of Core Borings

APPROXIMATE SITE LOCATION

# SITE VICINITY MAP



SITE VICINITY MAP
PEDESTRIAN BRIDGE FOUNDATION RETROFIT
AT NORTH BAYSHORE PARK
12220 N. BAYSHORE DRIVE
CITY OF NORTH MIAMI, FLORIDA

COUNTY: MIAMI-DADE COUNTY, FLORIDA
REFERENCE: GOOGLE EARTH, 2013
DATE: AUGUST, 2013

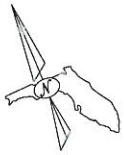
| DRAWN | SCALE | PROJ. No. |
|---|---|---|
| AI | N.T.S. | 213153 |
| CHECKED | DATE | |
| OR | AUG., 2013 | SHEET 1 |

**PEDESTRIAN BRIDGE FOUNDATION RETROFIT**
**AT NORTH BAYSHORE PARK**
**12220 N. BAYSHORE DRIVE**
**CITY OF NORTH MIAMI, FLORIDA**
**GEOSOL PROJECT No. 213153**

**TABLE 1 - SUMMARY OF APPROXIMATE TEST LOCATIONS**

| TEST No. | TEST TYPE | APPROXIMATE TEST LOCATION (FEET) | | GROUND SURFACE ELEVATION (FEET) |
|---|---|---|---|---|
| | | NORTHING | EASTING | |
| B-1 | SPT Boring | 566091.92 | 935031.61 | N/A |
| P-1 | Pile Integrity Test | 566004.69 | 935211.13 | N/A |
| P-2 | Pile Integrity Test | 566000.05 | 935221.84 | N/A |
| P-3 | Pile Integrity Test | 566035.71 | 935263.82 | N/A |
| P-4 | Pile Integrity Test | 566040.50 | 935273.65 | N/A |
| P-5 | Pile Integrity Test | 565966.15 | 935255.60 | N/A |

# BORING LOCATION PLAN



- B-1 APPROXIMATE TEST BORING LOCATION
- P-1 APPROXIMATE PILE INTEGRITY TESTING LOCATION

COUNTY: MIAMI-DADE COUNTY, FLORIDA

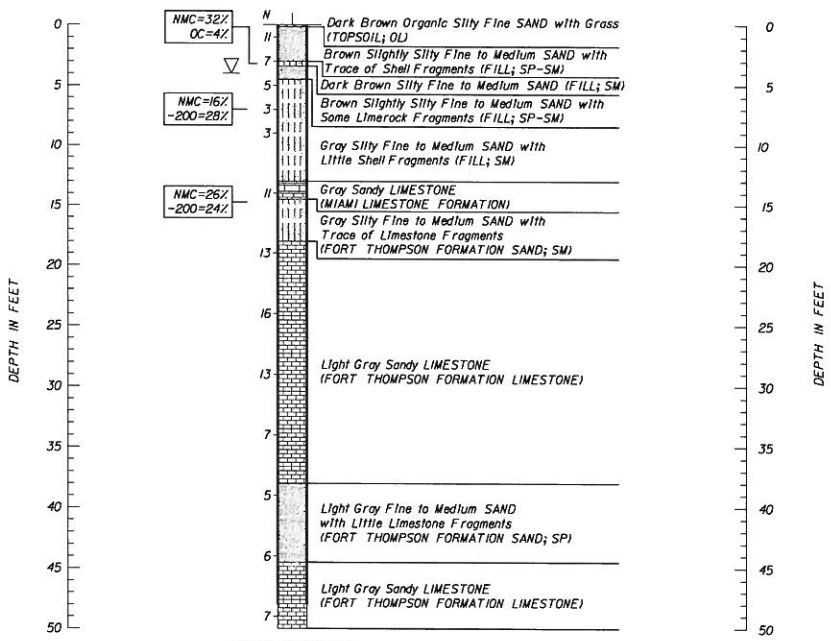
REFERENCE: GOOGLE EARTH, 2013

DATE: AUGUST, 2013

BORING LOCATION PLAN
PEDESTRIAN BRIDGE FOUNDATION RETROFIT
AT NORTH BAYSHORE PARK
12220 N. BAYSHORE DRIVE
CITY OF NORTH MIAMI, FLORIDA

| DRAWN | SCALE | PROJ. No. |
|---|---|---|
| AI | N.T.S. | 213153 |
| CHECKED | DATE | |
| OR | AUG., 2013 | SHEET 2 |

BOR # B-1
ELEV. N/A
DATE 8/1/2013
DRILLER R. Morales - GEOSOL, Inc.
HAMMER Auto
RIG B-53
NORTHING 566091.916
EASTING 935031.609




Boring Terminated at Depth of 50ft

Casing Length 48ft

## LEGEND

- Dark Brown Organic Silty Fine SAND with Grass (TOPSOIL; OL)
- Brown Slightly Silty Fine to Medium SAND with Trace to Some Shell and Limerock Fragments (FILL; SP-SM)
- Dark Brown to Gray Silty Fine to Medium SAND with Little Shell Fragments (FILL; SM)
- Gray Sandy LIMESTONE (MIAMI LIMESTONE FORMATION)
- Gray Silty Fine to Medium SAND with Trace of Limestone Fragments (FORT THOMPSON FORMATION SAND; SM)
- Light Gray Sandy LIMESTONE (FORT THOMPSON FORMATION LIMESTONE)
- Light Gray Fine to Medium SAND with Little Limestone Fragments (FORT THOMPSON FORMATION SAND; SP)

**NOTES:**

1) SPT BORINGS PERFORMED PER ASTM D-1586 WITH A HAMMER WEIGHT OF 140 LBS FALLING 30 INCHES.

▽ WATER TABLE AT TIME OF DRILLING

CASING USED

N NUMBERS TO THE LEFT OF BORINGS INDICATE SPT VALUE FOR 12" PENETRATION (UNLESS OTHERWISE NOTED).

NMC NATURAL MOISTURE CONTENT (%)

-200 FINES PASSING THE #200 SIEVE (%)

OC ORGANIC CONTENT (%)

**ENVIRONMENTAL CLASSIFICATION:**

SUPERSTRUCTURE: EXTREMELY AGGRESSIVE
SUBSTRUCTURE: EXTREMELY AGGRESSIVE (RESISTIVITY= 31 OHM-CM)

**WATER:**

pH: 7.6
CHLORIDE: 5,390 PPM
SULFATE: 650 PPM
RESISTIVITY: 31 OHM-CM

| GRANULAR MATERIALS- RELATIVE DENSITY | AUTOMATIC SPT HAMMER (BLOWS PER FOOT) |
|---|---|
| VERY LOOSE | LESS THAN 3 |
| LOOSE | 3-8 |
| MEDIUM DENSE | 8-24 |
| DENSE | 24-40 |
| VERY DENSE | GREATER THAN 40 |
| **SILTS AND CLAYS CONSISTANCY** | **AUTOMATIC SPT HAMMER (BLOWS PER FOOT)** |
| VERY SOFT | LESS THAN 1 |
| SOFT | 1-3 |
| FIRM | 3-6 |
| STIFF | 6-12 |
| VERY STIFF | 12-24 |
| HARD | GREATER THAN 24 |

0 2 10
Feet
VERTICAL SCALE
HORIZONTAL N.T.S.

REVISIONS

| DATE | BY | DESCRIPTION | DATE | BY | DESCRIPTION |
|---|---|---|---|---|---|
| | | | | | |

ENGINEER OF RECORD:
GEOSOL, INC.
ORACIO RICCOBONO, P.E.
PE LICENSE No. 49324
5795-A NW 151ST STREET
MIAMI LAKES, FL 33014
PHONE: (305) 828-4367
CERTIFICATE OF AUTHORIZATION 8530

DRAWN BY: S.G. 08-13
CHECKED BY: A.I. 08-13
DESIGNED BY: A.I. 08-13
CHECKED BY: D.P. 08-13

SHEET TITLE: REPORT OF CORE BORINGS

PROJECT NAME: NORTH BAYSHORE PARK BRIDGE RETROFIT

REF. DWG. NO.

SHEET NO. 3

Eddie 8/15/2013 3:57:00 PM Z:\2013\2013153\BORINGS.DWG

## APPENDIX "B"

Table 2 – Summary of Laboratory Test Results
Table 3 – Summary of Environmental Classification Test Results
Moisture Content Test Results
Percent Passing the No. 200 Sieve Test Results
Grain-Size Analysis Test Results and Curves
Organic Content Test Results
Environmental Classification Test Results

**TABLE 2 - SUMMARY OF LABORATORY TEST RESULTS**
**NORTH BAYSHORE PARK BRIDGE RETROFIT**
**CITY OF NORTH MIAMI, FLORIDA**
**GEOSOL Project No.: 213153**

| BORING NUMBER | SAMPLE NUMBER | USCS SYMBOL | Sample Depth (FEET) | Sieve Analysis (Percent Passing) | | | | | | | | | Organic Content (%) | Natural Moisture Content (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1" | 3/4" | 3/8" | #4 | #10 | #40 | #60 | #100 | #200 | | |
| B-1 | 2 | ML | 3.0 - 3.4 | - | - | - | - | - | - | - | - | - | 4 | 32 |
| B-1 | 6 | SM | 14.5 - 15.0 | - | - | - | - | - | - | - | - | 24 | - | 26 |
| B-1 | 4 | SP | 6.0 - 8.0 | 100 | 100 | 98 | 86 | 77 | 60 | 52 | 40 | 28 | - | 16 |

GEOSOL, Inc.

**TABLE 3 - SUMMARY OF ENVIRONMENTAL CLASSIFICATION TEST RESULTS**
**NORTH BAYSHORE PARK BRIDGE RETROFIT**
**CITY OR NORTH MIAMI, FLORIDA**
**GEOSOL PROJECT No.: 213153**

| Sample Location | Sample Type | Depth (ft) | pH | Resistivity (ohm-cm) | Chloride (ppm) | Sulfate (ppm) | FDOT ENVIRONMENTAL CLASSIFICATION | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Steel | Concrete |
| B-1 | WATER | 4 | 7.6 | 31 | 5,390 | 650 | EA | EA |

NOTES: (1) The following FDOT laboratory test methods were utilized.

FM5-550: pH — FM5-552: Chlorides

FM5-551: Resistivity — FM5-553: Sulfates

(2) SA: SLIGHTLY AGGRESSIVE

(3) MA: MODERATELY AGGRESSIVE

(4) EA: EXTREMELY AGGRESSIVE

FDOT Criteria for Substructure Environmental Classification (FDOT *Structures Design Guidelines* 2013)

| Classification | Environmental Condition | Units | Steel | | Concrete | |
|---|---|---|---|---|---|---|
| | | | Water | Soil | Water | Soil |
| Extremely Aggressive (If any of these conditions exist) | pH | | < 6.0 | | < 5.0 | |
| | Cl | ppm | > 2000 | | > 2000 | |
| | $SO_4$ | ppm | N.A. | | > 1500 | > 2000 |
| | Resistivity | Ohm-cm | < 1000 | | < 500 | |
| Slightly Aggressive (If all of these conditions exist) | pH | | > 7.0 | | > 6.0 | |
| | Cl | ppm | < 500 | | < 500 | |
| | $SO_4$ | ppm | N.A. | | < 150 | < 1000 |
| | Resistivity | Ohm-cm | > 5000 | | > 3000 | |
| Moderately Aggressive | This classification must be used at all sites not meeting requirements for either slightly aggressive or extremely aggressive environments. | | | | | |
| pH = acidity ($-\log_{10}H^+$; potential of Hydrogen), Cl = chloride content, $SO_4$ = Sulfate content. | | | | | | |

# MOISTURE CONTENT TEST RESULTS (ASTM D-2216)

**PROJECT NAME:** NORTH BAYSHORE PARK BRIDGE RETROFIT
**LOCATION:** CITY OF NORTH MIAMI, FLORIDA
**PROJECT No.:** 213153
**DATE:** 08/12/2013

| Boring No. | B-1 | B-1 | B-1 |
|---|---|---|---|
| Sample No. | 2 | 6 | 4 |
| Sample Depth (Feet) | 3-3.4 | 14.5-15 | 6-8 |
| Tare No. | 17 | 101 | 30 |
| Tare plus wet soil (grams) | 202.0 | 236.5 | 226.0 |
| Tare plus dry soil (grams) | 155.5 | 190.0 | 196.0 |
| Water $W_w$ (grams) | 46.5 | 46.5 | 30.0 |
| Tare (grams) | 8.5 | 8.5 | 9.0 |
| Dry soil $W_s$ (grams) | 147.0 | 181.5 | 187.0 |
| Water Content w (%) | 31.6 | 25.6 | 16.0 |

## MATERIAL PASSING THE # 200 SIEVE TEST RESULTS (AASHTO T-11)

**PROJECT NAME:** NORTH BAYSHORE PARK BRIDGE RETROFIT
**LOCATION:** CITY OF NORTH MIAMI, FLORIDA
**PROJECT No.:** 213153
**DATE:** 08/12/2013

| Boring No. | B-1 | B-1 |
|---|---|---|
| Sample No. | 6 | 4 |
| Sample Depth (Feet) | 14.5-15 | 6-8 |
| Original Dry Weight of Soil (grams) | 181.5 | 187.0 |
| Weight of Soil After Washing (grams) | 138.5 | 134.5 |
| Weight of Soil Passing 200 Sieve (grams) | 43.0 | 52.5 |
| Percent of Soil Passing 200 Sieve (%) | 23.7 | 28.1 |

**Note:** The percent passing the No. 200 sieve results presented above were determined using the wash method.

# GRAIN SIZE DATA SHEET

**DATE:** 8/14/2013

**PROJECT NAME:** NORTH BAYSHORE PARK BRIDGE RETROFIT
**GEOSOL PROJECT No.** 213153
**GENERAL LOCATION:** CITY OF NORTH MIAMI, FLORIDA

**Boring No.** B-1
**Sample No.** 4
**Depth (feet)** 6-8

**SOIL DESCRIPTION:** Gray Silty Fine to Medium SAND with Little Limerock Fragments (FILL; SM)

| Tare # | Dry Wt. - Tare Wt. |
|---|---|
| 30 | 187.0 |
| | |

| Sieve Size | Sieve Sizes | Cumulative Wt. Retained | % RETAINED | % PASSING | % PASSING TOTAL SAMPLE | WEIGHT RETAINED (Grams) |
|---|---|---|---|---|---|---|
| 75 | 75mm 3" | 0.0 | 0.0 | 100 | 100 | 0.0 |
| 50 | 50mm 2" | 0.0 | 0.0 | 100 | 100 | 0.0 |
| 37.5 | 37.5mm 1.5" | 0.0 | 0.0 | 100.0 | 100.0 | 0.0 |
| 25 | 25mm 1" | 0.0 | 0.0 | 100.0 | 100.0 | 0.0 |
| 19 | 19mm 3/4" | 0.0 | 0.0 | 100.0 | 100.0 | 0.0 |
| 9.5 | 9.5mm 3/8" | 3.5 | 1.9 | 98.1 | 98.1 | 3.5 |
| 4.75 | 4.75mm #4 | 25.5 | 13.6 | 86.4 | 86.4 | 22.0 |
| 2.36 | 2 mm #10 | 43.0 | 23.0 | 77.0 | 77.0 | 17.5 |
| 0.6 | 425um #40 | 74.0 | 39.6 | 60.4 | 60.4 | 31.0 |
| 0.3 | 250um #60 | 89.0 | 47.6 | 52.4 | 52.4 | 15.0 |
| 0.15 | 150um #100 | 112.0 | 59.9 | 40.1 | 40.1 | 23.0 |
| 0.075 | 75um #200 | 134.5 | 71.9 | 28.1 | 28.1 | 22.5 |
| PAN | - | 187.0 | 100.0 | 0.0 | 0.0 | 52.5 |

**NOTES:** Percent passing the #200 sieve was determined by the wash method.

ASTM D 2487 Classification of Soil for Engineering Purposes

| | |
|---|---|
| Coarse Gravel | < 3" and > 3/4" |
| Fine Gravel | < 3/4" and > #4 |
| Coarse Sand | < #4 and > #10 |
| Medium Sand | < #10 and > #40 |
| Fine Sand | < #40 and > #200 |

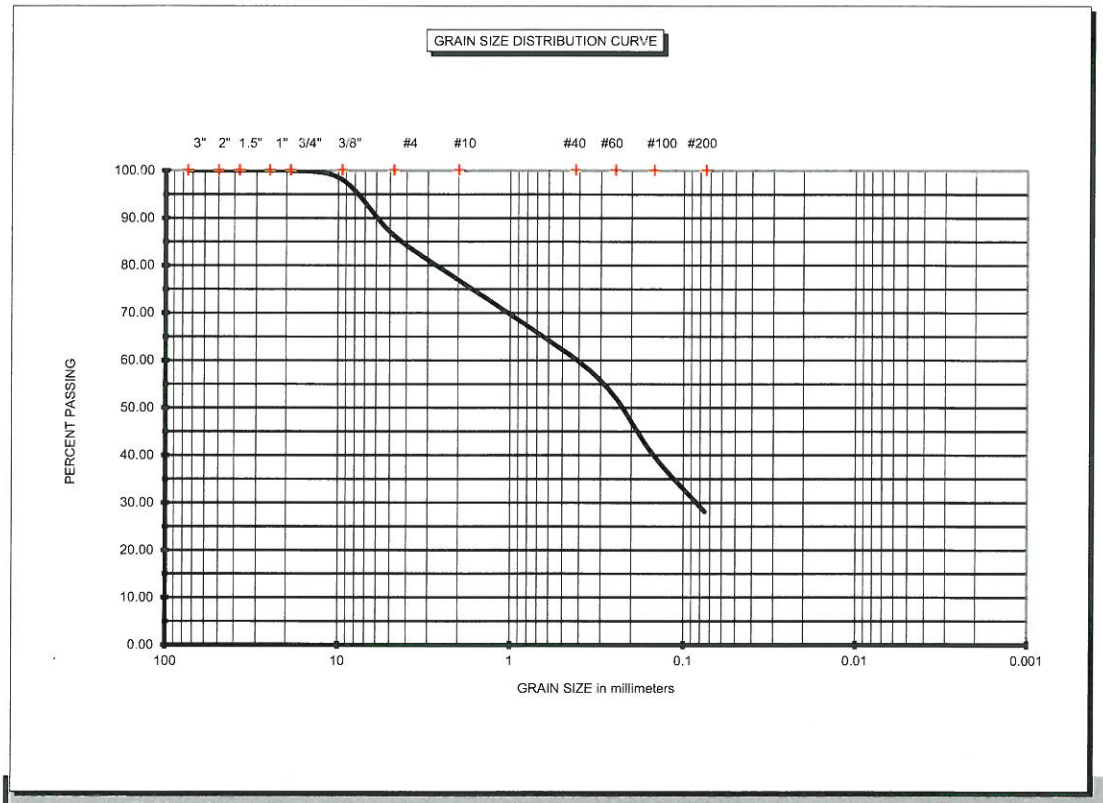
Cu = D60 / D10
Cc = (D30)^2 / (D10 x D60)
1000 um = 1 mm

tested by: O. Riccobono computed by: O. Riccobono checked by: D.R.

# GRAIN SIZE DATA SHEET

DATE: 8/14/2013

**PROJECT NAME:** NORTH BAYSHORE PARK BRIDGE RETROFIT
**GEOSOL PROJECT No.** 213153
**GENERAL LOCATION:** CITY OF NORTH MIAMI, FLORIDA




| ASTM D 2487 Classification of Soil for Engineering Purposes | | | Coarse Sand | < #4 and > #10 | Cu = D60 / D10 |
|---|---|---|---|---|---|
| Coarse Gravel | < 3" and > 3/4" | | Medium Sand | < #10 and > #40 | Cc = (D30)^2 / (D10 x D60) |
| Fine Gravel | < 3/4" and > #4 | | Fine Sand | < #40 and > #200 | |

**BORING #** B-1 **SAMPLE #** 4 **Depth (feet)** 6-8

**SOIL DESCRIPTION:** Gray Silty Fine to Medium SAND with Little Limerock Fragments (FILL; SM)

**Natural Moisture Content:** 16.0%

# ORGANIC CONTENT TEST RESULTS (ASTM D-2974)

**PROJECT NAME:** NORTH BAYSHORE PARK BRIDGE RETROFIT
**LOCATION** CITY OF NORTH MIAMI, FLORIDA
**PROJECT No.** 213153
**DATE:** 08/12/2013

| | |
|---|---|
| Boring No. | B-1 |
| Sample No. | 2 |
| Sample Depth (Feet) | 3-3.4 |
| Crucible No. | B |
| Weight of Crucible and Oven-Dried Sample (grams) | 124.5 |
| Weight of Crucible and Sample after Ignition (grams) | 122.0 |
| Weight of Crucible (grams) | 67.0 |
| Weight of Oven-Dried Soil (grams) | 57.5 |
| Weight Loss due to Ignition (grams) | 2.5 |
| Percent Organics (%) | 4.3 |

Pace Analytical Services, Inc.
3610 Park Central Blvd N
Pompano Beach, FL 33064
954-582-4300

# ANALYTICAL RESULTS

Project: North Bay Shore Park Fishing
Pace Project No.: 35102772

**Sample: B-1** **Lab ID: 35102772001** Collected: 08/01/13 06:00 Received: 08/02/13 16:40 Matrix: Water

| Parameters | Results | Units | PQL | MDL | DF | Prepared | Analyzed | CAS No. | Qual |
|---|---|---|---|---|---|---|---|---|---|
| **Resistivity** | Analytical Method: EPA 120.1 Resistivity | | | | | | | | |
| Resistivity | **31.0** | ohms-cm | | | 1 | | 08/08/13 17:00 | | |
| **4500H+ pH, Electrometric** | Analytical Method: SM 4500-H+B | | | | | | | | |
| Temperature, Water (C) | **25.0** | deg C | 0.010 | 0.010 | 1 | | 08/05/13 14:55 | | |
| pH at 25 Degrees C | **7.6** | Std. Units | 0.10 | 0.10 | 1 | | 08/05/13 14:55 | | Q |
| **300.0 IC Anions 28 Days** | Analytical Method: EPA 300.0 | | | | | | | | |
| Chloride | **5390** | mg/L | 500 | 250 | 100 | | 08/05/13 18:39 | 16887-00-6 | |
| Sulfate | **650** | mg/L | 250 | 125 | 50 | | 08/05/13 00:43 | 14808-79-8 | |



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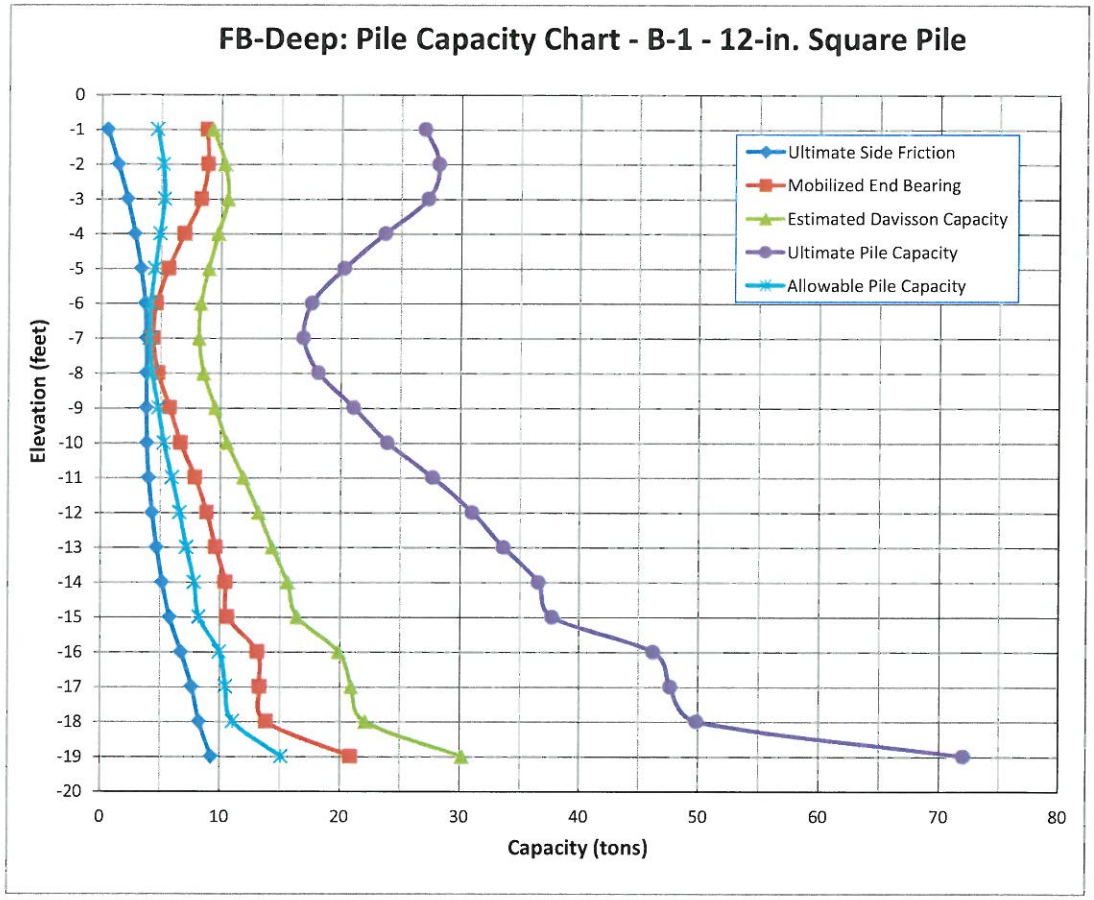
**APPENDIX "C"**

Driven Piles: Axial Compression Capacity Output and Curves (FB-Deep Runs)

**Project:** North Bayshore Park Fishing Pier Foundation Retrofit
**Project No.:** 213153
**Location:** Miami-Dade County, FL
**Boring No.:** B-1 (12-in. Square Pile)



Florida Bridge Software Institute
Shaft and Pile Analysis (FB-Deep v.2.04)

Date: August 15, 2013
Time: 09:52:48

General Information:
==========
Input file: .....sktop\North Bayshore Park Fishing Pier Foundation Retrofit.spc
Project number: 213153
Job name: North Bayshore Park Foundation Retrofit
Engineer: Adnan Ismail, P.E.
Units: English

Analysis Information:
==========
Analysis Type: SPT

Soil Information:
==========
Boring date: 8/1/2013, Boring Number: B-1
Station number: Offset:

Ground Elevation: 0.000(ft)

Hammer type: Automatic Hammer, Correction factor = 1.24

| ID | Depth (ft) | No. of Blows (Blows/ft) | Soil Type |
|---|---|---|---|
| 1 | 0.00 | 0.00 | 5- Cavity layer |
| 2 | 1.00 | 11.00 | 3- Clean sand |
| 3 | 3.00 | 7.00 | 3- Clean sand |
| 4 | 5.00 | 5.00 | 3- Clean sand |
| 5 | 7.00 | 3.00 | 3- Clean sand |
| 6 | 9.00 | 3.00 | 3- Clean sand |
| 7 | 14.00 | 11.00 | 4- Lime Stone/Very shelly sand |
| 8 | 16.00 | 11.00 | 3- Clean sand |
| 9 | 19.00 | 13.00 | 4- Lime Stone/Very shelly sand |
| 10 | 24.00 | 16.00 | 4- Lime Stone/Very shelly sand |
| 11 | 29.00 | 13.00 | 4- Lime Stone/Very shelly sand |
| 12 | 34.00 | 7.00 | 4- Lime Stone/Very shelly sand |
| 13 | 39.00 | 5.00 | 3- Clean sand |
| 14 | 44.00 | 6.00 | 3- Clean sand |
| 15 | 49.00 | 7.00 | 4- Lime Stone/Very shelly sand |

Blowcount Average Per Soil Layer

| Layer Num. | Starting Elevation (ft) | Bottom Elevation (ft) | Thickness (ft) | Average Blowcount (Blows/ft) | Soil Type |
|---|---|---|---|---|---|
| 1 | 0.00 | -1.00 | 1.00 | 0.00 | 5-Void |
| 2 | -1.00 | -14.00 | 13.00 | 5.15 | 3-Clean Sand |
| 3 | -14.00 | -16.00 | 2.00 | 11.00 | 4-Limestone, Very Shelly Sand |
| 4 | -16.00 | -19.00 | 3.00 | 11.00 | 3-Clean Sand |
| 5 | -19.00 | -39.00 | 20.00 | 12.25 | 4-Limestone, Very Shelly Sand |
| 6 | -39.00 | -49.00 | 10.00 | 5.50 | 3-Clean Sand |
| 7 | -49.00 | -49.00 | 0.00 | 7.00 | 4-Limestone, Very Shelly Sand |





Driven Pile Data:
==========
Pile unit weight = 150.00(pcf), Section Type: Square

Pile Geometry:

| Width (in) | Length (ft) | Tip Elev. (ft) |
|---|---|---|
| 12.00 | 1.00 | -1.00 |
| 12.00 | 2.00 | -2.00 |
| 12.00 | 3.00 | -3.00 |
| 12.00 | 4.00 | -4.00 |
| 12.00 | 5.00 | -5.00 |
| 12.00 | 6.00 | -6.00 |
| 12.00 | 7.00 | -7.00 |
| 12.00 | 8.00 | -8.00 |
| 12.00 | 9.00 | -9.00 |
| 12.00 | 10.00 | -10.00 |
| 12.00 | 11.00 | -11.00 |
| 12.00 | 12.00 | -12.00 |
| 12.00 | 13.00 | -13.00 |
| 12.00 | 14.00 | -14.00 |
| 12.00 | 15.00 | -15.00 |
| 12.00 | 16.00 | -16.00 |
| 12.00 | 17.00 | -17.00 |
| 12.00 | 18.00 | -18.00 |
| 12.00 | 19.00 | -19.00 |

Driven Pile Capacity:
==========

| Test Pile Length (ft) | Pile Width (in) | Ultimate Side Friction (tons) | Mobilized End Bearing (tons) | Estimated Davisson Capacity (tons) | Allowable Pile Capacity (tons) | Ultimate Pile Capacity (tons) |
|---|---|---|---|---|---|---|
| 1.00 | 12.0 | 0.52 | 8.81 | 9.33 | 4.66 | 26.95 |
| 2.00 | 12.0 | 1.41 | 8.89 | 10.31 | 5.15 | 28.10 |
| 3.00 | 12.0 | 2.21 | 8.33 | 10.55 | 5.27 | 27.22 |
| 4.00 | 12.0 | 2.83 | 6.94 | 9.77 | 4.89 | 23.66 |
| 5.00 | 12.0 | 3.35 | 5.64 | 8.99 | 4.49 | 20.27 |
| 6.00 | 12.0 | 3.70 | 4.62 | 8.32 | 4.16 | 17.56 |
| 7.00 | 12.0 | 3.82 | 4.35 | 8.17 | 4.08 | 16.87 |
| 8.00 | 12.0 | 3.82 | 4.77 | 8.58 | 4.29 | 18.12 |
| 9.00 | 12.0 | 3.82 | 5.76 | 9.57 | 4.79 | 21.09 |
| 10.00 | 12.0 | 3.87 | 6.67 | 10.54 | 5.27 | 23.88 |
| 11.00 | 12.0 | 4.03 | 7.88 | 11.91 | 5.96 | 27.67 |
| 12.00 | 12.0 | 4.31 | 8.89 | 13.20 | 6.60 | 30.98 |
| 13.00 | 12.0 | 4.69 | 9.64 | 14.33 | 7.16 | 33.61 |
| 14.00 | 12.0 | 5.18 | 10.45 | 15.63 | 7.82 | 36.54 |
| 15.00 | 12.0 | 5.79 | 10.64 | 16.43 | 8.22 | 37.72 |
| 16.00 | 12.0 | 6.76 | 13.15 | 19.91 | 9.96 | 46.21 |
| 17.00 | 12.0 | 7.63 | 13.33 | 20.97 | 10.48 | 47.64 |

B-1 - 12-in

| | | | | | | |
|---|---|---|---|---|---|---|
| 18.00 | 12.0 | 8.26 | 13.86 | 22.12 | 11.06 | 49.85 |
| 19.00 | 12.0 | 9.29 | 20.91 | 30.19 | 15.10 | 72.00 |

NOTES
---

1. MOBILIZED END BEARING IS 1/3 OF THE ORIGINAL RB-121 VALUES.

2. DAVISSON PILE CAPACITY IS AN ESTIMATE BASED ON FAILURE CRITERIA, AND EQUALS ULTIMATE SIDE FRICTION PLUS MOBILIZED END BEARING.

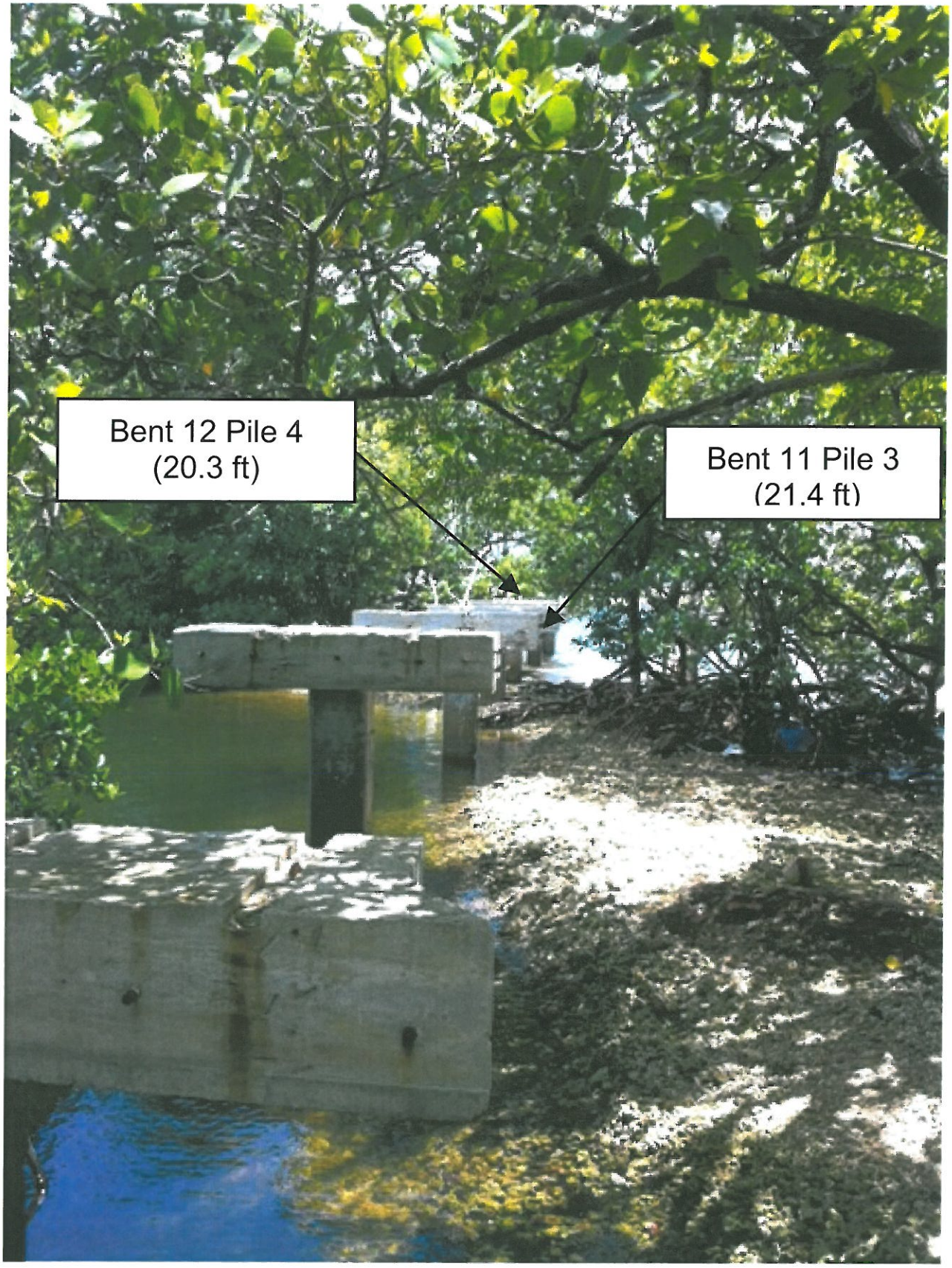
3. ALLOWABLE PILE CAPACITY IS 1/2 THE DAVISSON PILE CAPACITY.

4. ULTIMATE PILE CAPACITY IS ULTIMATE SIDE FRICTION PLUS 3 x THE MOBILIZED END BEARING.
   EXCEPTION: FOR H-PILES TIPPED IN SAND OR LIMESTONE, THE ULTIMATE PILE CAPACITY IS ULTIMATE SIDE FRICTION PLUS 2 x THE MOBILIZED END BEARING.

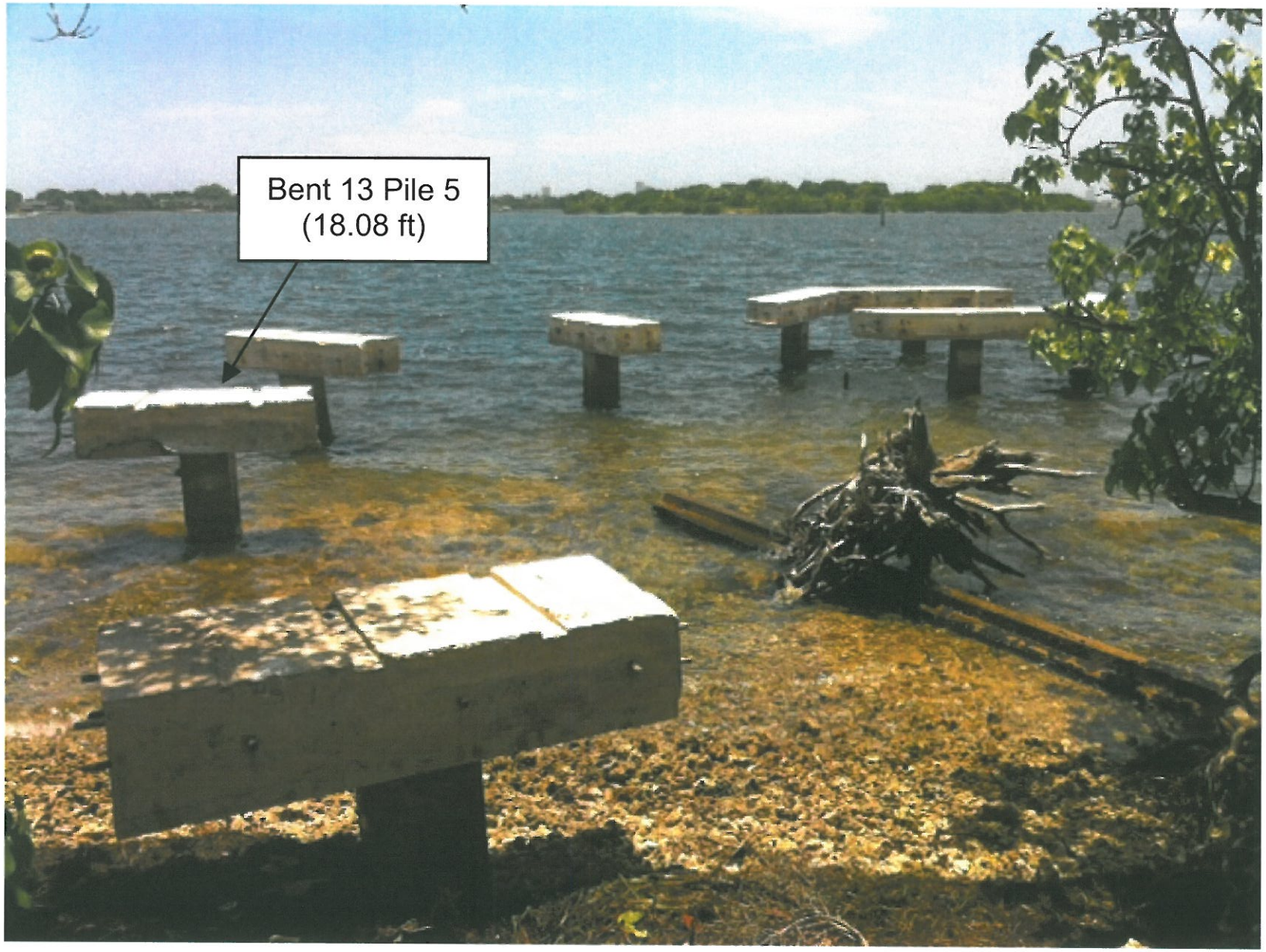
**APPENDIX "D"**

Site Photographs
Pile Integrity Testing Impact Diagrams

**Picture 1**




**Picture 2**




**Picture 3**

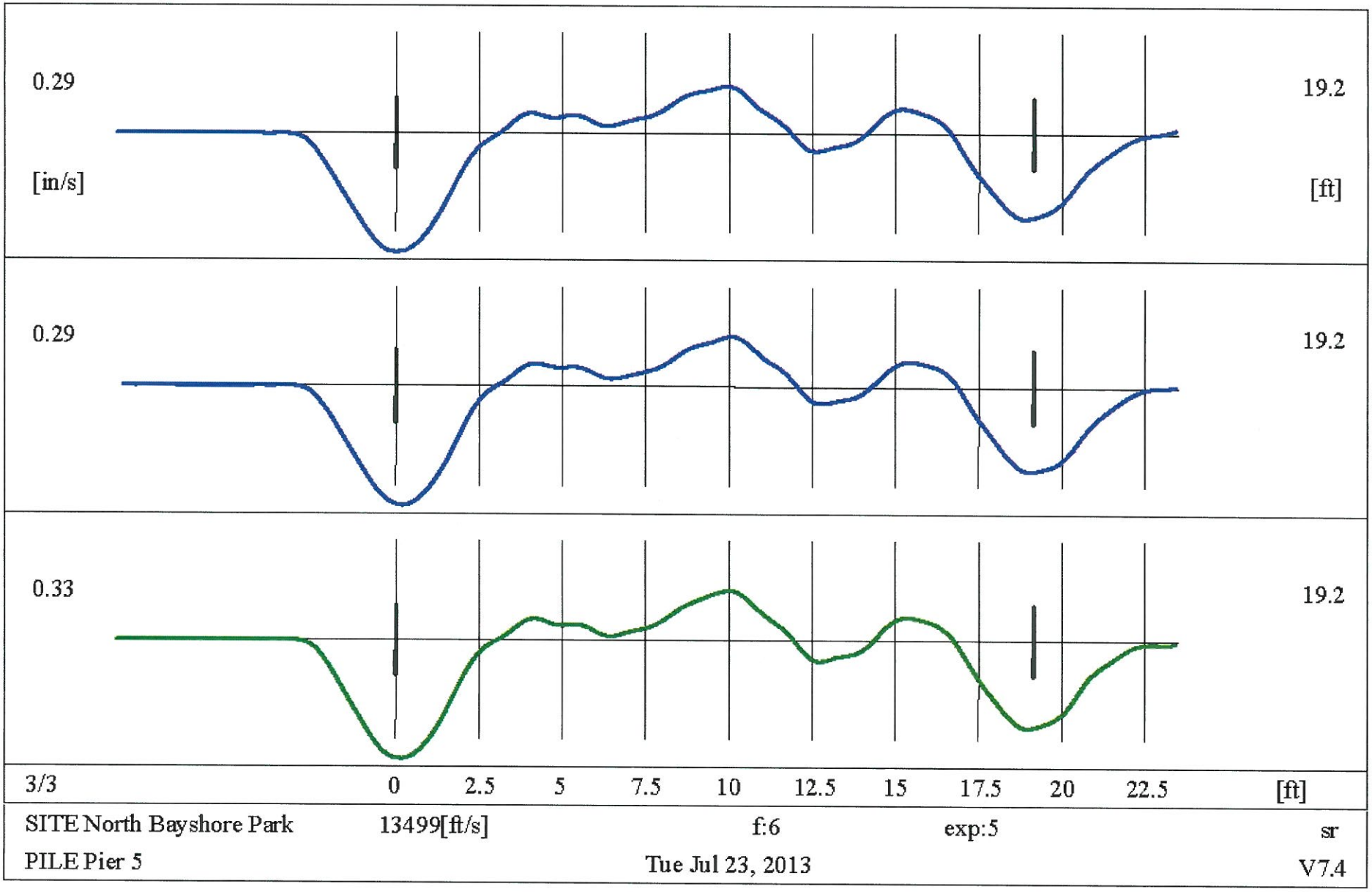

0.29
[in/s]
19.2
[ft]
0.29
19.2
0.33
19.2
3/3
0
2.5
5
7.5
10
12.5
15
17.5
20
22.5
[ft]
SITE North Bayshore Park
13499[ft/s]
f:6
exp:5
sr
PILE Pier 5
Tue Jul 23, 2013
V7.4

**Fig 1**
**P–1**

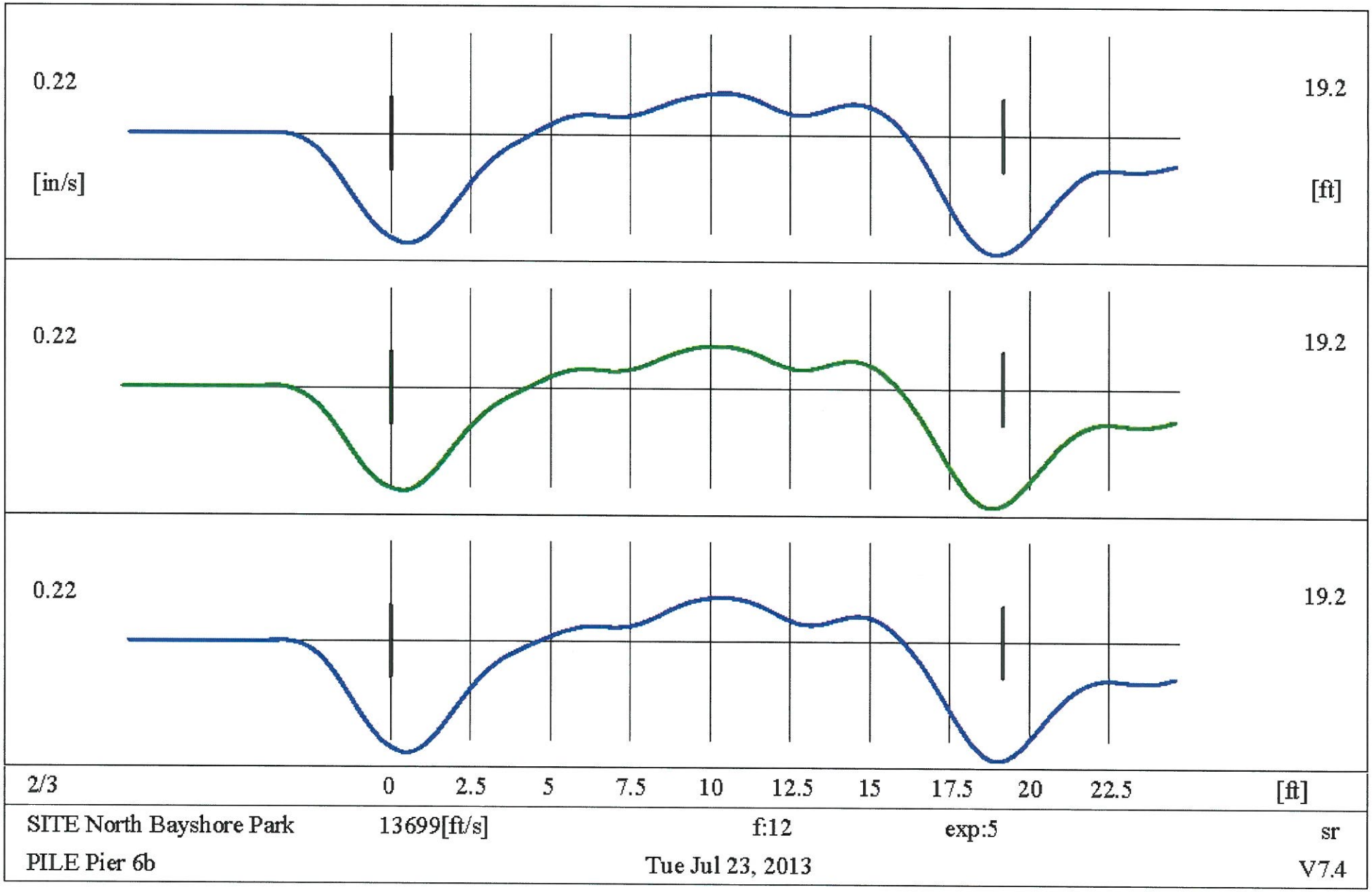

0.22
[in/s]
19.2
[ft]
0.22
19.2
0.22
19.2
2/3
0
2.5
5
7.5
10
12.5
15
17.5
20
22.5
[ft]
SITE North Bayshore Park
13699[ft/s]
f:12
exp:5
sr
PILE Pier 6b
Tue Jul 23, 2013
V7.4

**Fig 2**
**P– 2**

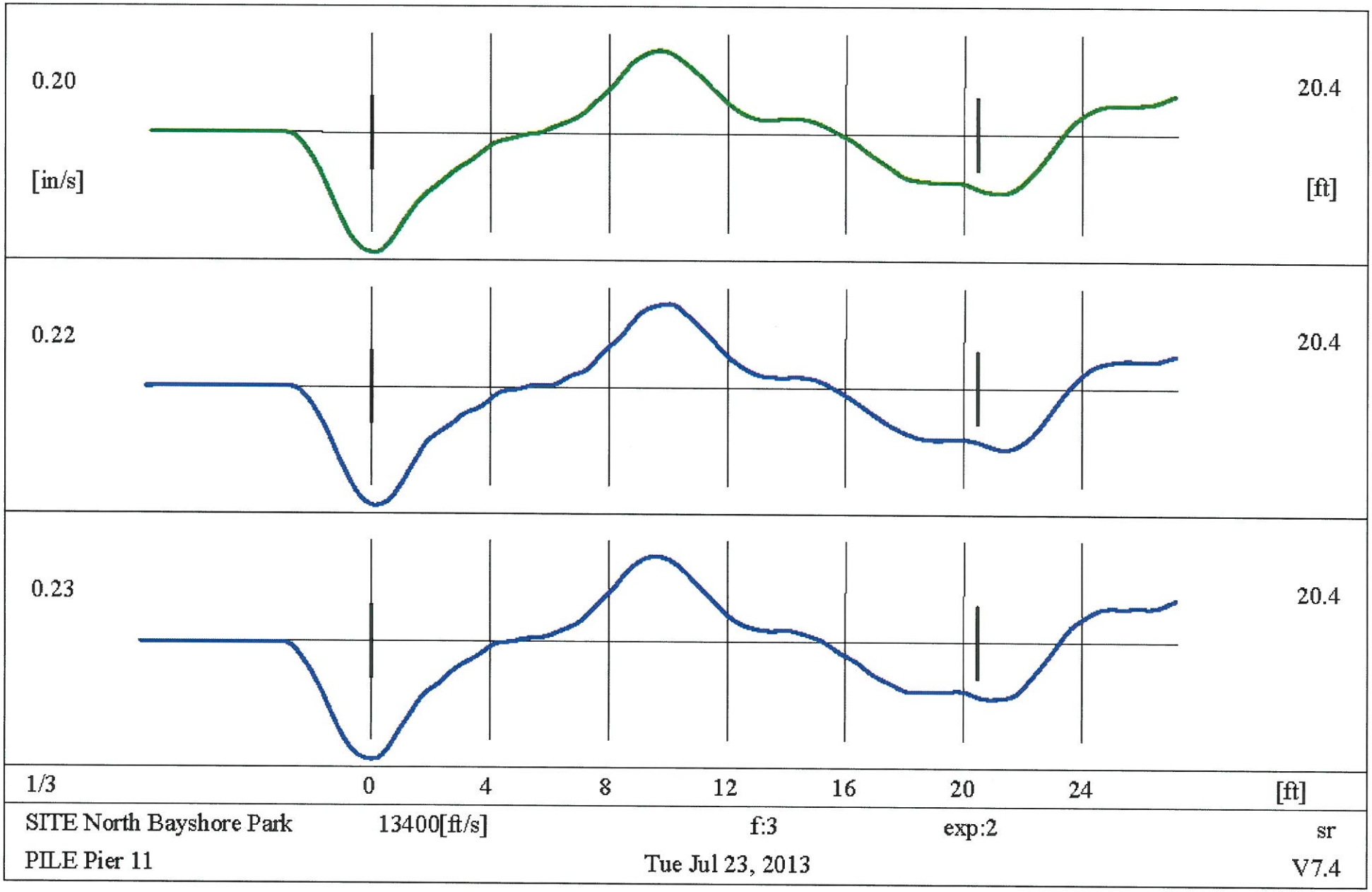

0.20
[in/s]
20.4
[ft]
0.22
20.4
0.23
20.4
1/3
0
4
8
12
16
20
24
[ft]
SITE North Bayshore Park
13400[ft/s]
f:3
exp:2
sr
PILE Pier 11
Tue Jul 23, 2013
V7.4

**Fig 3**
**P–3**

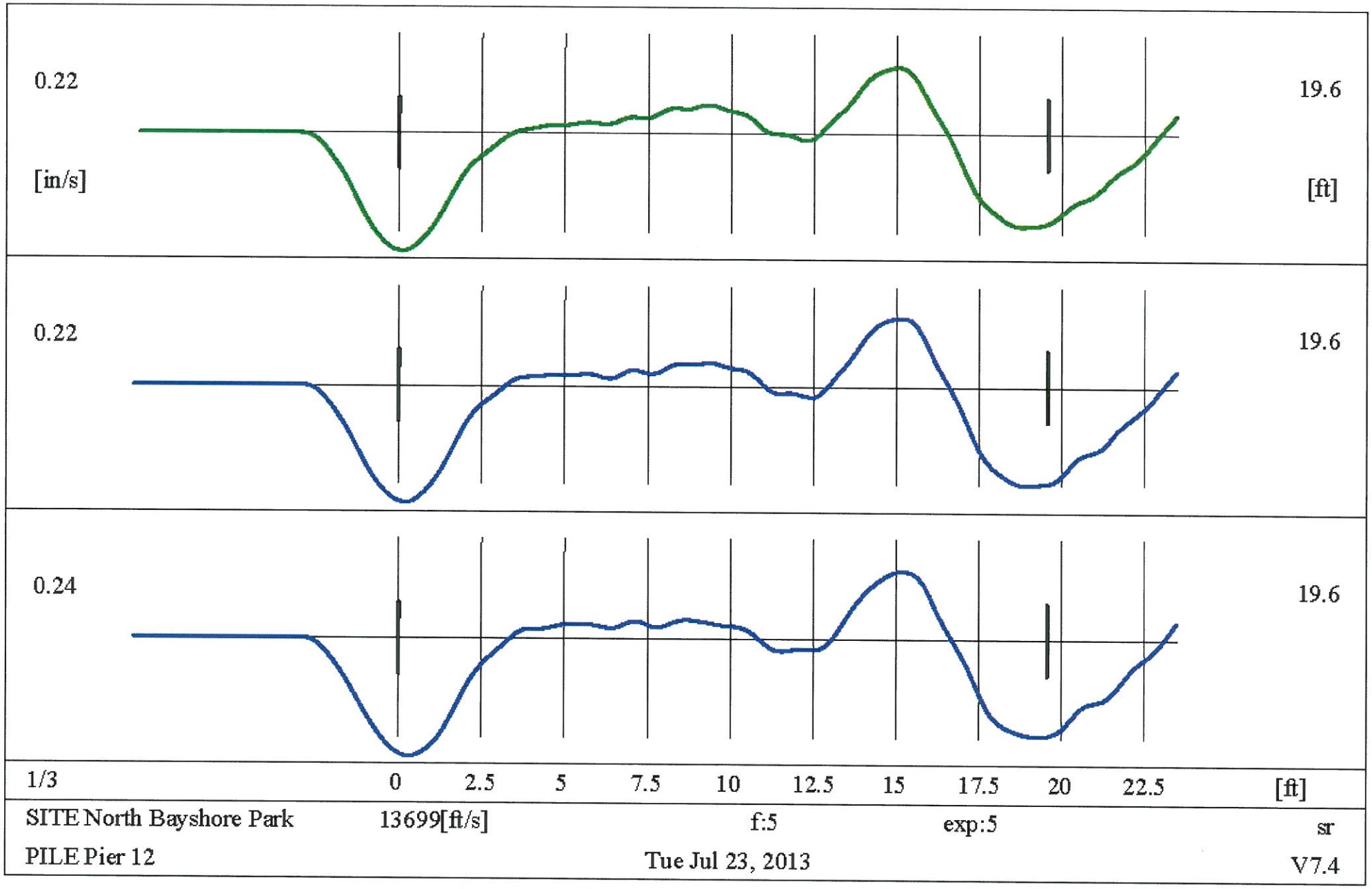

0.22
[in/s]
19.6
[ft]
0.22
19.6
0.24
19.6
1/3
0
2.5
5
7.5
10
12.5
15
17.5
20
22.5
[ft]
SITE North Bayshore Park
13699[ft/s]
f:5
exp:5
sr
PILE Pier 12
Tue Jul 23, 2013
V7.4

**Fig 4**
**P–4**

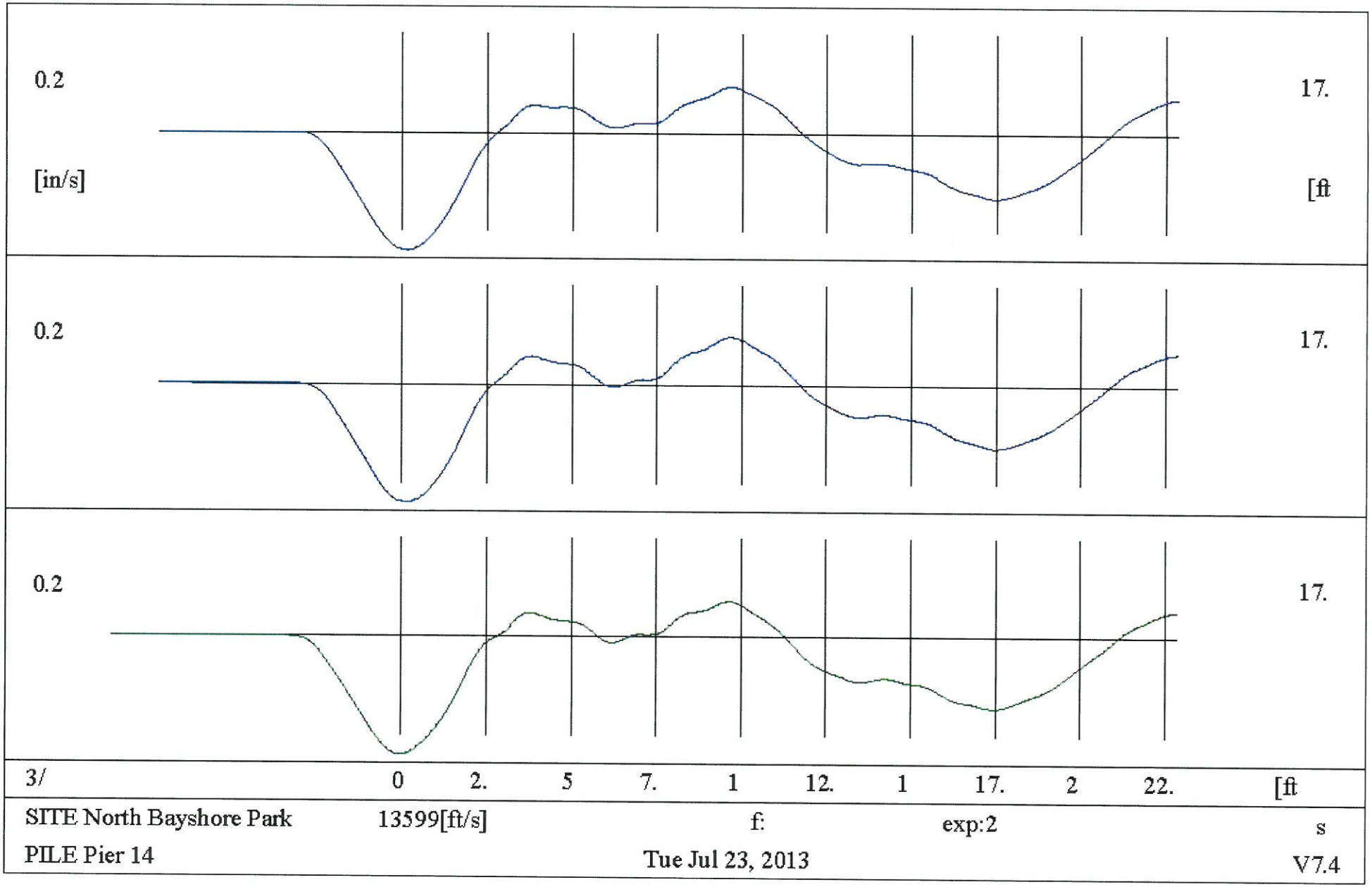
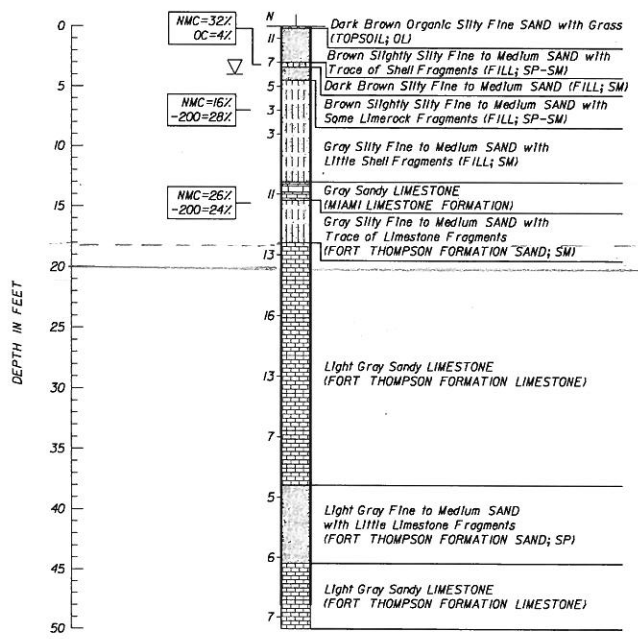

0.2
[in/s]
17.
[ft
0.2
17.
0.2
17.
3/
0
2.
5
7.
1
12.
1
17.
2
22.
[ft
SITE North Bayshore Park
13599[ft/s]
f:
exp:2
s
PILE Pier 14
Tue Jul 23, 2013
V7.4

**Fig 5**
**P-5**

# 5.0 AXIAL PILE CAPACITY

DESIGN CRITERIA

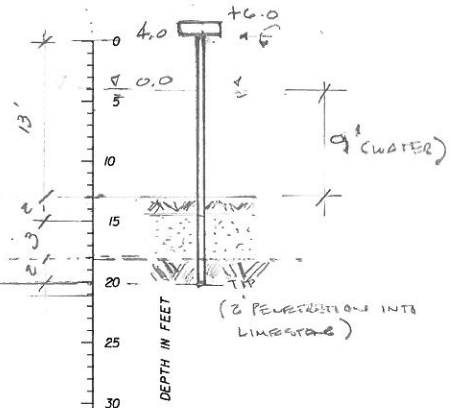
BOR # B-1
ELEV. N/A
DATE 8/1/2013
DRILLER R. Morales - GEOSOL, Inc.
HAMMER Auto
RIG B-53
NORTHING 566091.916
EASTING 935031.609




Boring Terminated at Depth of 50ft

Casing Length 48ft

WATERSIDE PILES




## LEGEND

- Dark Brown Organic Silty Fine SAND with Grass (TOPSOIL; OL)
- Brown Slightly Silty Fine to Medium SAND with Trace to Some Shell and Limerock Fragments (FILL; SP-SM)
- Dark Brown to Gray Silty Fine to Medium SAND with Little Shell Fragments (FILL; SM)
- Gray Sandy LIMESTONE (MIAMI LIMESTONE FORMATION)
- Gray Silty Fine to Medium SAND with Trace of Limestone Fragments (FORT THOMPSON FORMATION SAND; SM)
- Light Gray Sandy LIMESTONE (FORT THOMPSON FORMATION LIMESTONE)
- Light Gray Fine to Medium SAND with Little Limestone Fragments (FORT THOMPSON FORMATION SAND; SP)

**NOTES:**

1) SPT BORINGS PERFORMED PER ASTM D-1586 WITH A HAMMER WEIGHT OF 140 LBS FALLING 30 INCHES.

▽ WATER TABLE AT TIME OF DRILLING

❙❙ CASING USED

N NUMBERS TO THE LEFT OF BORINGS INDICATE SPT VALUE FOR 12" PENETRATION (UNLESS OTHERWISE NOTED).

NMC NATURAL MOISTURE CONTENT (%)

-200 FINES PASSING THE #200 SIEVE (%)

OC ORGANIC CONTENT (%)

**ENVIRONMENTAL CLASSIFICATION:**

SUPERSTRUCTURE: EXTREMELY AGGRESSIVE
SUBSTRUCTURE: EXTREMELY AGGRESSIVE (RESISTIVITY= 31 OHM-CM)

**WATER:**

pH: 7.6
CHLORIDE: 5,390 PPM
SULFATE: 650 PPM
RESISTIVITY: 31 OHM-CM

| GRANULAR MATERIALS-RELATIVE DENSITY | AUTOMATIC SPT HAMMER (BLOWS PER FOOT) |
|---|---|
| VERY LOOSE | LESS THAN 3 |
| LOOSE | 3-8 |
| MEDIUM DENSE | 8-24 |
| DENSE | 24-40 |
| VERY DENSE | GREATER THAN 40 |
| **SILTS AND CLAYS CONSISTANCY** | **AUTOMATIC SPT HAMMER (BLOWS PER FOOT)** |
| VERY SOFT | LESS THAN 1 |
| SOFT | 1-3 |
| FIRM | 3-6 |
| STIFF | 6-12 |
| VERY STIFF | 12-24 |
| HARD | GREATER THAN 24 |

0 2 10
Feet
VERTICAL SCALE
HORIZONTAL N.T.S.

| REVISIONS | | | | | |
|---|---|---|---|---|---|
| DATE | BY | DESCRIPTION | DATE | BY | DESCRIPTION |
| | | | | | |


ENGINEER OF RECORD:
GEOSOL, INC.
ORACIO RICCOBONO, P.E.
PE LICENSE No. 49324
5795-A NW 151ST STREET
MIAMI LAKES, FL 33014
PHONE: (305) 828-4367
CERTIFICATE OF AUTHORIZATION 8530


DRAWN BY: S.B. 08-13
CHECKED BY: A.I. 08-13
DESIGNED BY: A.I. 08-13
CHECKED BY: O.R. 08-13

SHEET TITLE: REPORT OF CORE BORINGS

PROJECT NAME: NORTH BAYSHORE PARK BRIDGE RETROFIT

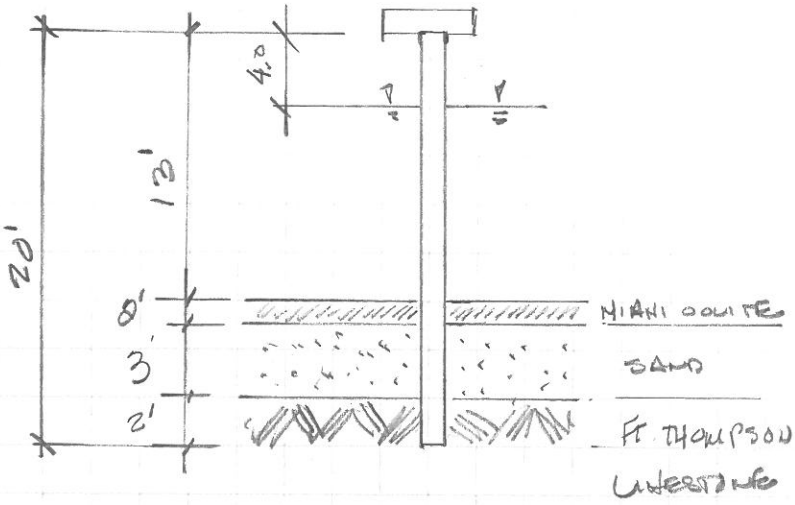
REF. DWG. NO.

SHEET NO. 3

Edsile 8/15/2013 3:27:00 PM Z:\2013\3153\BORING.DGN

## AXIAL CAPACITY

ESTIMATE AXIAL CAPACITY FOR WATERSIDE PILES:




FOR WATERSIDE PILES, ASSUME NO PILE EMBEDMENT IN FILL.

USE TOP OF NATURAL GROUND (MIAMI OOLITE LAYER)

FROM CAPACITY CURVES:

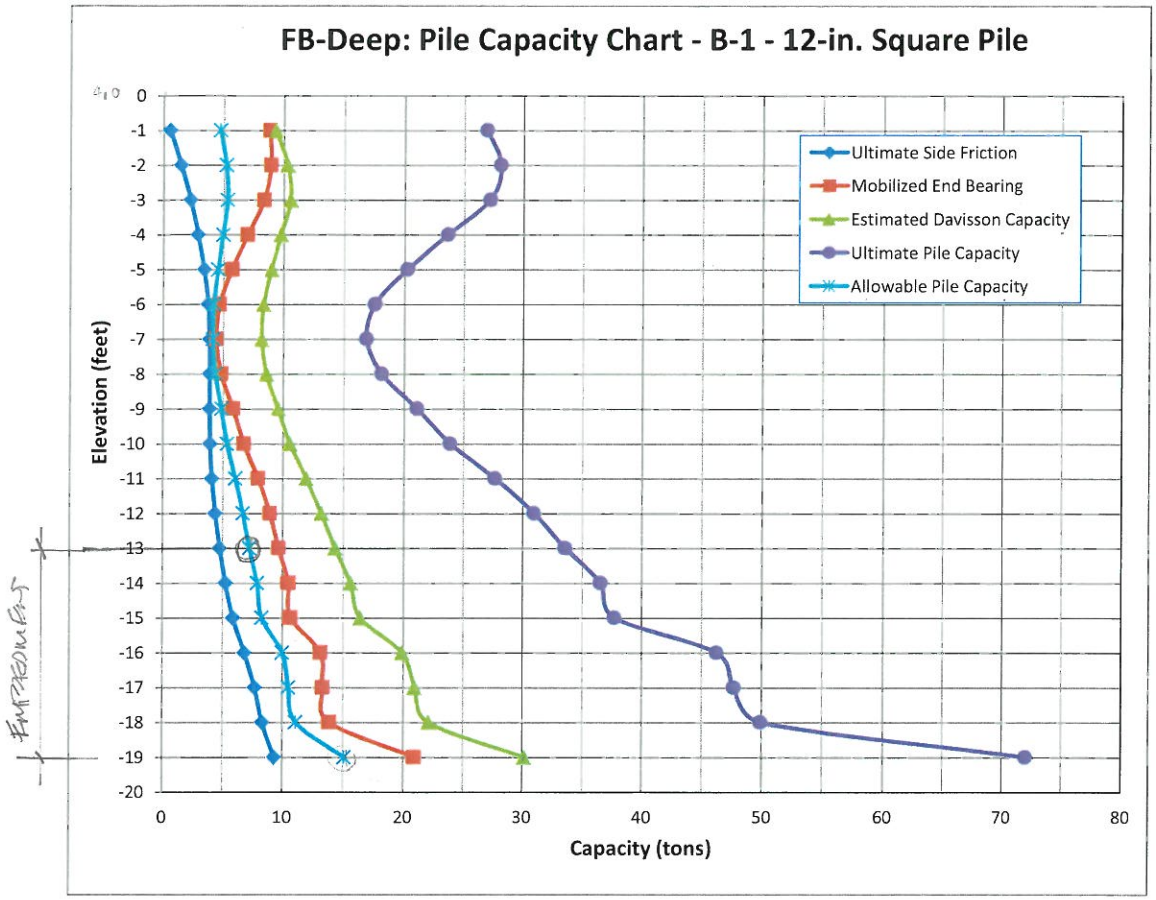
PILE CAPACITY @ TIP = 15 TONS ALLOWABLE

CAPACITY FOR TOP 13' = - 7 TONS

NET = 8 TONS ALLOWABLE CAPACITY

**Project:** North Bayshore Park Fishing Pier Foundation Retrofit
**Project No.:** 213153
**Location:** Miami-Dade County, FL
**Boring No.:** B-1 (12-in. Square Pile)

WATERSIDE PILES




ALLOWABLE 13 - 7 = 6 TON AXIAL CAPACITY FOR WATERWARD PILES

# 6. LATERAL PILE CAPACITY

## LATERAL CAPACITY

NOTE: WATERSIDE PILES ARE CRITICAL DUE TO REDUCED EMBEDMENT.

1. DETERMINE ALLOWABLE MOMENT CAPACITY OF THE 12" SQ. PRESTRESSED CONCRETE PILES

$A_c = 144 \text{ in}^2$ CHECK FOR 8-1/2"φ, GRADE 270 LRS STRANDS

$S_c = 288 \text{ in}^3$

$f'_c = 6000 \text{ psi}$

STRESS to 75% OF $f_{pu}$ & ASSUME 15% LOSSES

$f_{se} = 0.75(.85)(270) = 166 \text{ ksi}$ $A_{ps} = 8(.153 \text{ in}^2) = 1.224 \text{ in}^2$

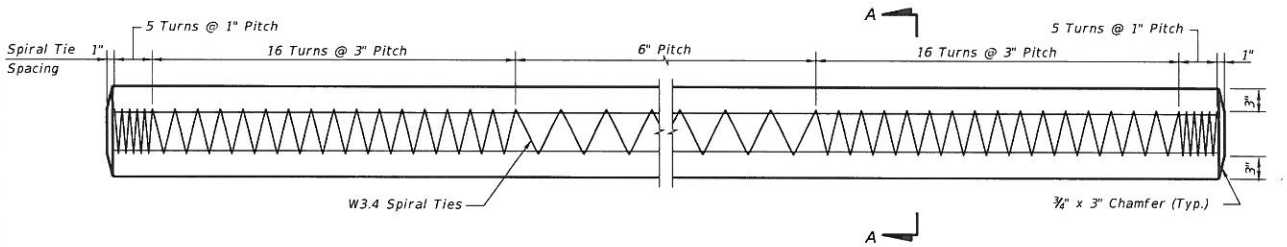
$$f_{pc} = \frac{f_{se}(A_{ps})}{A_c} = \frac{166(1.224)}{144} = 1.411 \text{ ksi}$$

ALLOWABLE MOMENT

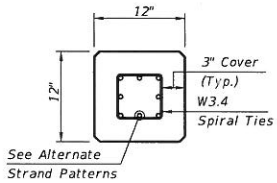
$$M_a = \left(4\sqrt{f'_c} + f_{pc}\right) S$$

$$= \left(\frac{4\sqrt{6000}}{1000} + 1.411\right) 288$$

$$\boxed{M_a = 496 \text{ k-in}}$$



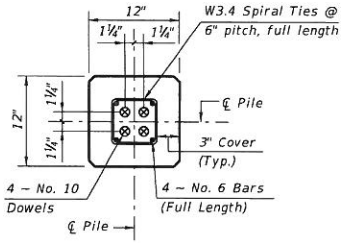

ELEVATION



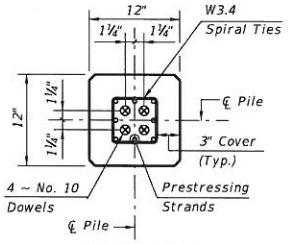

SECTION A-A

## ALTERNATE STRAND PATTERNS

4 ~ 0.6" Ø, Grade 270 LRS, at 44 kips
8 ~ ½" Ø (Special), Grade 270 LRS, at 25 kips
8 ~ ½" Ø, Grade 270 LRS, at 24 kips
8 ~ 7/16" Ø, Grade 270 LRS, at 23 kips
12 ~ 3/13" Ø, Grade 270 LRS, at 16 kips




SECTION D-D
(See Nondrivable Unforeseen Reinforced Precast Pile Splice Detail)




SECTION E-E
(See Drivable Unforeseen Prestressed Precast Pile Splice Detail)

PILE SPLICE REINFORCEMENT DETAILS

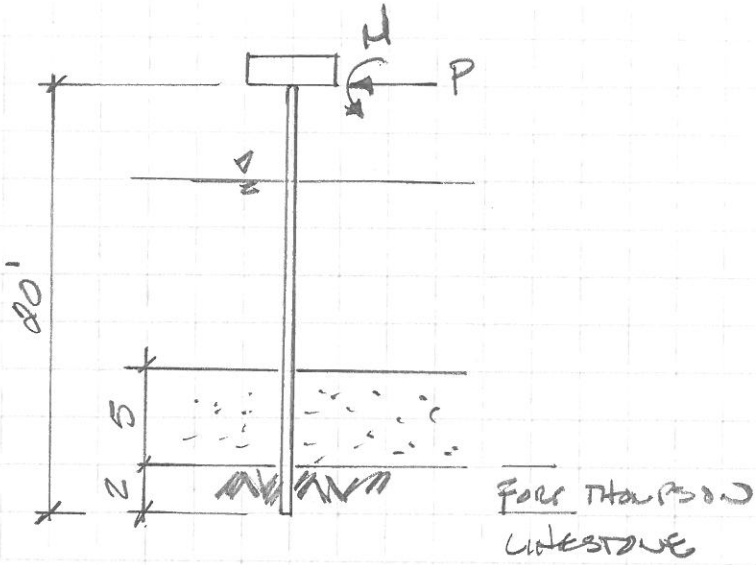
NOTES:
1. Work this Index with Index No. 20600 - Notes and Details for Square Prestressed Concrete Piles and Index No. 20601 - Square Prestressed Concrete Pile Splices.
2. Any of the given Alternate Strand Patterns may be utilized. The strands shall be located as follows:
   Place one strand at each corner and place the remaining strands equally spaced between the corner strands.
   The total strand pattern shall be concentric with the nominal concrete section of the pile.

| LAST REVISION | REVISION | DESCRIPTION: | | | | INDEX NO. | SHEET NO. |
|---|---|---|---|---|---|---|---|
| 01/01/12 | | | FDOT DESIGN STANDARDS 2013 | 12" SQUARE PRESTRESSED CONCRETE PILE | | 20612 | 1 |

6/28/2012 1:31:15 PM r49681nh C:\S\projects\standards\structures\2013book\20612-1of1.dgn

2. DETERMINE THE MAXIMUM LATERAL LOAD

FOR $M_a = 496$ K-IN.




BASED ON SOIL PROFILE (BORING B-1) AND ESTIMATED PILE LENGTH FROM PIT TESTING ($L \approx 20'$), IT IS REASONABLE TO EXPECT 2' OF PENETRATION INTO THE FORT THOMPSON LIMESTONE.

REFER TO LPILE ANALYSIS:

A MAXIMUM LATERAL FORCE, APPLIED AT THE TOP OF THE CONCRETE CAP OF 2.6 KIPS IS PERMISSIBLE.

$$\boxed{P_{LAT} = 2.6 \text{ KIPS}}$$

==========

LPile Plus for Windows, Version 2012-06.037

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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==========

This copy of LPile is licensed to:

Frank Tejidor
Bermello Ajamil & Partners

Serial Number of Security Device: 160706414
Company Name Stored in Security Device: Bermello-Ajamil & Partners

---

## Files Used for Analysis

---

Path to file locations: C:\Documents and Settings\ftejidor\My Documents\
Name of input data file: NBayshore.final.lp6d
Name of output report file: NBayshore.final.lp6o
Name of plot output file: NBayshore.final.lp6p
Name of runtime messeage file: NBayshore.final.lp6r

---

## Date and Time of Analysis

---

Date: August 28, 2013 Time: 14:23:09

---

## Problem Title

---

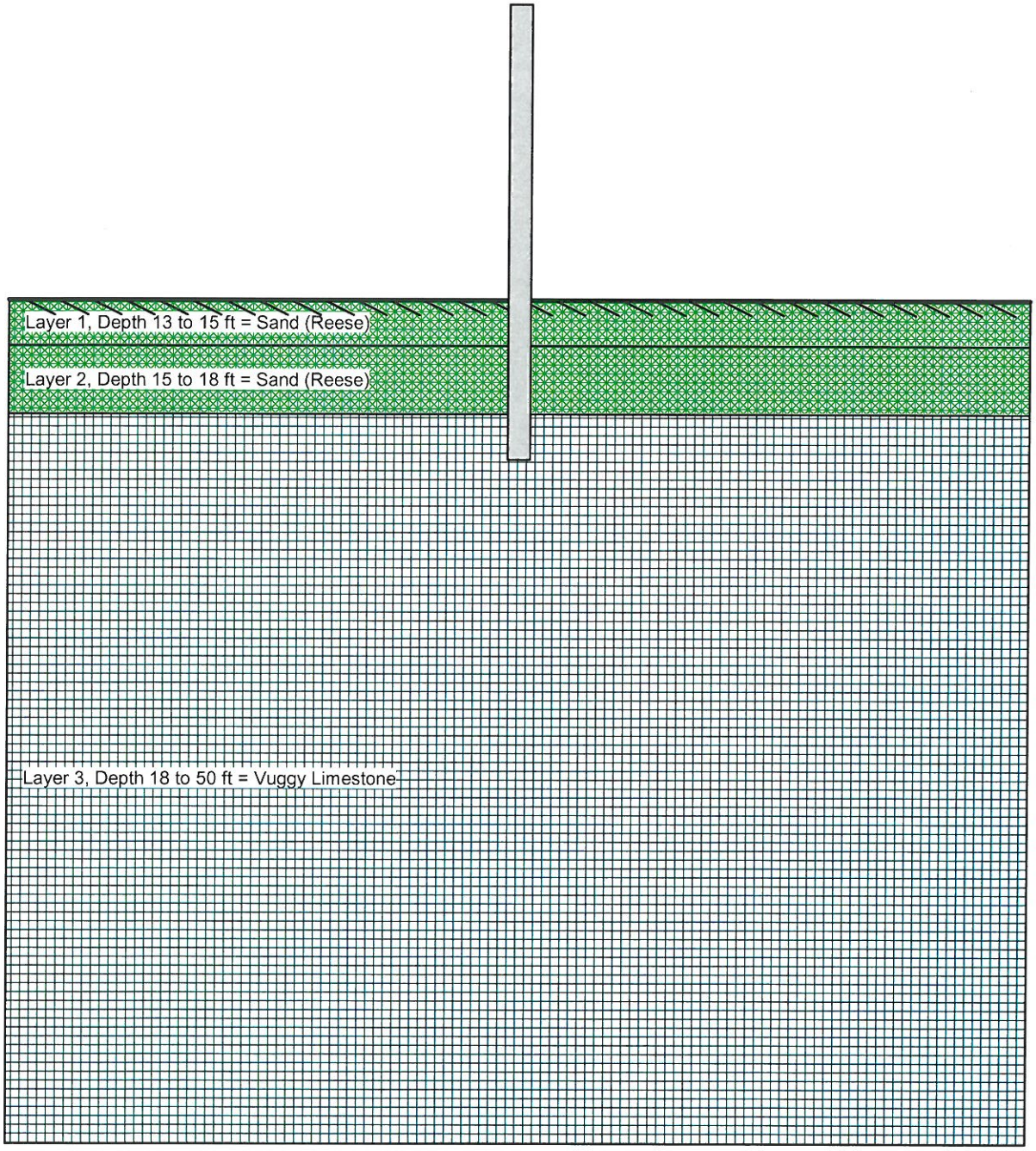
Project Name: North Bayshore Park

Job Number:

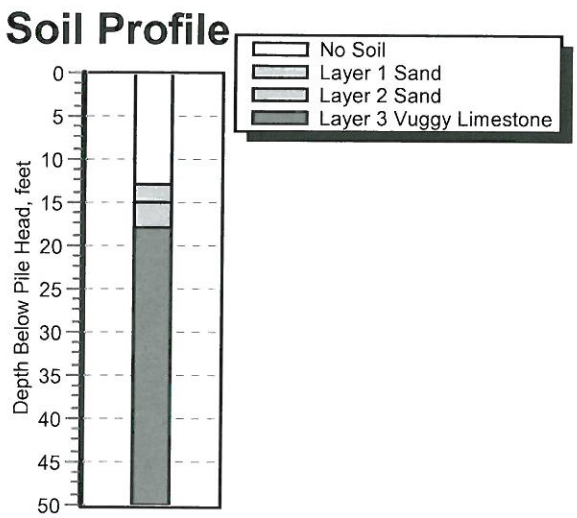
Client: City of North Miami

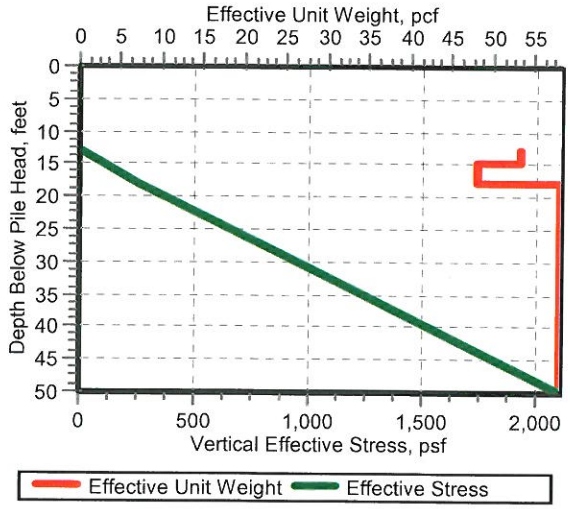
Engineer: F. Tejidor

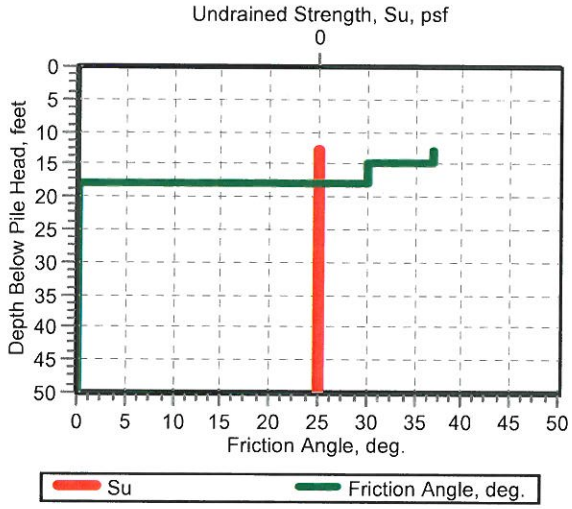
Description: Lateral Load Capacity

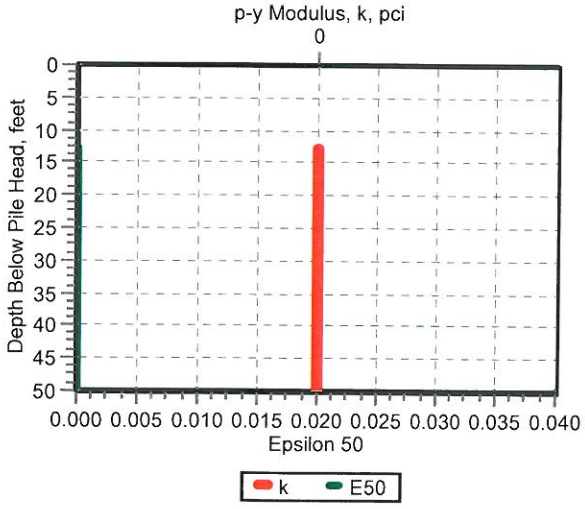


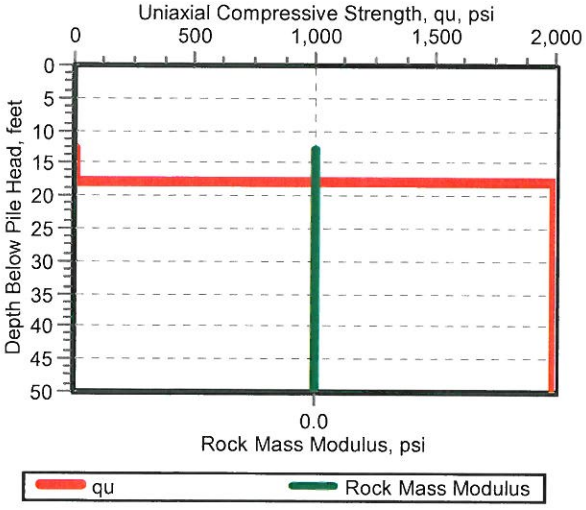

LPile 2012.6.37, © 2013 by Ensoft, Inc.

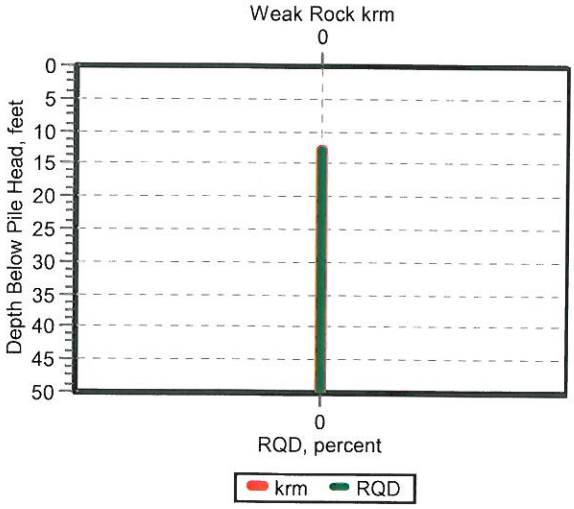

Soil Profile
No Soil
Layer 1 Sand
Layer 2 Sand
Layer 3 Vuggy Limestone
Depth Below Pile Head, feet
0
5
10
15
20
25
30
35
40
45
50


Effective Unit Weight, pcf
0 5 10 15 20 25 30 35 40 45 50 55
Depth Below Pile Head, feet
0 5 10 15 20 25 30 35 40 45 50
0 500 1,000 1,500 2,000
Vertical Effective Stress, psf
Effective Unit Weight
Effective Stress


Undrained Strength, Su, psf
0
Depth Below Pile Head, feet
0 5 10 15 20 25 30 35 40 45 50
0 5 10 15 20 25 30 35 40 45 50
Friction Angle, deg.
Su
Friction Angle, deg.


p-y Modulus, k, pci
0
Depth Below Pile Head, feet
0 5 10 15 20 25 30 35 40 45 50
0.000 0.005 0.010 0.015 0.020 0.025 0.030 0.035 0.040
Epsilon 50
k
E50


Uniaxial Compressive Strength, qu, psi
0 500 1,000 1,500 2,000
Depth Below Pile Head, feet
0 5 10 15 20 25 30 35 40 45 50
0.0
Rock Mass Modulus, psi
qu
Rock Mass Modulus


Weak Rock krm
0
Depth Below Pile Head, feet
0 5 10 15 20 25 30 35 40 45 50
0
RQD, percent
krm
RQD

---

## Program Options

---

Engineering units are US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes pile response to lateral loading and will compute nonlinear moment-curvature and nominal moment capacity for section types with nonlinear properties.

Computation Options:
- Analysis does not use p-y multipliers (individual pile or shaft only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix values
- Report pile response for full length of pile
- Analysis assumes no loading by soil movements acting on pile
- No p-y curves to be computed and reported for user-specified depths

Solution Control Parameters:

| | | | |
|---|---|---|---|
| - Number of pile increments | = | 100 | |
| - Maximum number of iterations allowed | = | 100 | |
| - Deflection tolerance for convergence | = | 1.0000E-05 | in |
| - Maximum allowable deflection | = | 100.0000 | in |

Pile Response Output Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (nodal spacing of output points) = 1

---

## Pile Structural Properties and Geometry

---

Total number of pile sections = 1

Total length of pile = 20.00 ft

Depth of ground surface below top of pile = 13.00 ft

Pile diameter values used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over the length of the pile.

| Point | Depth X ft | Pile Diameter in |
|---|---|---|
| 1 | 0.00000 | 12.0000000 |
| 2 | 20.000000 | 12.0000000 |

Input Structural Properties:
---

Pile Section No. 1:

```
Section Type = Square Solid Prestressed Pile
Section Length                                    =     20.00000000 ft
Pile Width                                        =     12.00000000 in
Corner Chamfer                                    =      0.0000000 in
```

---

Ground Slope and Pile Batter Angles

---

```
Ground Slope Angle                                =        0.000 degrees
                                                  =        0.000 radians

Pile Batter Angle                                 =        0.000 degrees
                                                  =        0.000 radians
```

---

Soil and Rock Layering Information

---

The soil profile is modelled using 3 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

```
Distance from top of pile to top of layer         =     13.00000 ft
Distance from top of pile to bottom of layer      =     15.00000 ft
Effective unit weight at top of layer             =     53.00000 pcf
Effective unit weight at bottom of layer          =     53.00000 pcf
Friction angle at top of layer                    =     37.00000 deg.
Friction angle at bottom of layer                 =     37.00000 deg.
Subgrade k at top of layer                        =       0.0000 pci
Subgrade k at bottom of layer                     =       0.0000 pci

NOTE: Internal default values for subgrade k will be computed for
      the above soil layer.
```

Layer 2 is sand, p-y criteria by Reese et al., 1974

```
Distance from top of pile to top of layer         =     15.00000 ft
Distance from top of pile to bottom of layer      =     18.00000 ft
Effective unit weight at top of layer             =     48.00000 pcf
Effective unit weight at bottom of layer          =     48.00000 pcf
Friction angle at top of layer                    =     30.00000 deg.
Friction angle at bottom of layer                 =     30.00000 deg.
Subgrade k at top of layer                        =       0.0000 pci
Subgrade k at bottom of layer                     =       0.0000 pci

NOTE: Internal default values for subgrade k will be computed for
      the above soil layer.
```

Layer 3 is strong rock (vuggy limestone)

```
Distance from top of pile to top of layer         =     18.00000 ft
Distance from top of pile to bottom of layer      =     50.00000 ft
Effective unit weight at top of layer             =     58.00000 pcf
Effective unit weight at bottom of layer          =     58.00000 pcf
Uniaxial compressive strength at top of layer     =   2000.00000 psi
Uniaxial compressive strength at bottom of layer  =   2000.00000 psi
```

(Depth of lowest soil layer extends 30.00 ft below pile tip)

## Summary of Soil Properties

| Layer Num. | Soil Type (p-y Curve Criteria) | Layer Depth ft | Effective Unit Wt. pcf | Angle of Friction deg. | Uniaxial qu psi | kpy pci |
|---|---|---|---|---|---|---|
| 1 | Sand (Reese, et al.) default | 13.000 | 53.000 | 37.000 | -- | -- |
| | default | 15.000 | 53.000 | 37.000 | -- | -- |
| 2 | Sand (Reese, et al.) default | 15.000 | 48.000 | 30.000 | -- | -- |
| | default | 18.000 | 48.000 | 30.000 | -- | -- |
| 3 | Vuggy Limestone | 18.000 | 58.000 | -- | 2000.000 | -- |
| | | 50.000 | 58.000 | -- | 2000.000 | -- |

## Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

## Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

| Load No. | Load Type | Condition 1 | Condition 2 | Axial Thrust Force, lbs | Compute Top y vs. Pile Length |
|---|---|---|---|---|---|
| 1 | 1 | V = 2600.00000 lbs | M = 5200.00000 in-lbs | 0.0000000 | Yes |

V = perpendicular shear force applied to pile head
M = bending moment applied to pile head
y = lateral deflection relative to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applie to pile head
Axial thrust is assumed to be acting axially for all pile batter angles.

---

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

Dimensions of Square Prestressed Pile Section:

| | | | |
|---|---|---|---|
| Length of Section | = | 20.000 | ft |
| Pile Width | = | 12.000 | in |
| Corner Chamfer | = | 0.000 | in |

Prestressing Strand Details:

| | | | |
|---|---|---|---|
| Strand Type | = | PCI 270 | |
| Yield Stress, fpu | = | 270. | ksi |
| Stress-strain curve for reinforcement defined ssing PCI 270 Lo-lax equation | | | |
| If eps > 0.008 fpu = 268 - 0.075/(eps-0.0065) < 0.98 fpu (ksi) | | | |
| Number of Reinforcing Strands | = | 8 | |
| Cross-sectional Area of Single Strand | = | 0.153 | sq. in. |
| Concrete Cover Thickness Over Strands | = | 3.000 | in |

Prestressing Strand Geometry:

| Strand No. | Diameter in | Area Sq. in | X in | Y in |
|---|---|---|---|---|
| 1 | 0.500 | 0.153 | -2.750 | -2.750 |
| 2 | 0.500 | 0.153 | 0.000 | -2.750 |
| 3 | 0.500 | 0.153 | 2.750 | -2.750 |
| 4 | 0.500 | 0.153 | 2.750 | 0.000 |
| 5 | 0.500 | 0.153 | 2.750 | 2.750 |
| 6 | 0.500 | 0.153 | 0.000 | 2.750 |
| 7 | 0.500 | 0.153 | -2.750 | 2.750 |
| 8 | 0.500 | 0.153 | -2.750 | 0.000 |

Computation of Loss of Prestress:

| | | | |
|---|---|---|---|
| Initial Prestressing Force | = | 203.184 | kips |
| Fraction of Loss of Prestress | = | 0.180 | |
| Effective Prestressing Force | = | 166.611 | kips |
| Area of Concrete, Ac | = | 142.776 | Sq. in |
| Area of Steel, As | = | 1.224 | Sq. in |
| Stress in Concrete After Losses, f_pc | = | 1.167 | ksi |
| Stress in Steel After Losses | = | -136.120 | ksi |
| Compressive Strain in Concrete | = | 0.0002643 | |
| Tensile Strain in Steel | = | -0.0048614 | |

Estimated Structural Capacities Computed Using PCI Equations:

| | | | |
|---|---|---|---|
| Nom. Axial Cap., Pn = (0.85 f'c - 0.60 f_pc) Ag | = | 633.576 | kips |
| Unfac. Axial Load Cap. N = (0.33 f'c - 0.27 f_pc) Ag | = | 239.749 | kips |

Axial Capacity in Tension, Nt = As fpu = -330.480 kips
Nom. Moment Capacity, Mn = 0.37 D As fpu = 1467.331 in-kip

Note: The above value of nominal moment capacity is based on equations that assume a concrete compressive strength of 6,000 psi (41.4 MPa), a prestressing level after losses of 700 psi (4.83 MPa), and an axial thrust loading of zero. When different values for these factors are input, the estimated value of Mn may differ greatly from the capacity computed by LPile and should be considered only as an approximate check.

Concrete Properties:
---

| | | | |
|---|---|---|---|
| Compressive Strength of Concrete | = | 6.00000000 | ksi |
| Modulus of Elasticity of Concrete | = | 4415.20101468 | ksi |
| Modulus of Rupture of Prestressed Concrete | = | -0.30983868 | ksi |
| Compression Strain at Peak Stress | = | 0.00231020 | |
| Tensile Strain at Fracture of Concrete | = | -0.00006044 | |
| Maximum Coarse Aggregate Size | = | 0.75000000 | in |

Number of Axial Thrust Force Values Determined from Pile-head Loadings = 1

| Number | Axial Thrust Force kips |
|---|---|
| 1 | 0.000 |

Definitions of Run Messages and Notes:
---

C = concrete in section has cracked in tension.
Y = stress in reinforcing steel has reached yield stress.
T = ACI 318-08 criteria for tension-controlled section met, tensile strain in reinforcement exceeds 0.005 while simultaneously compressive strain in concrete more than than 0.003. See ACI 318-08, Section 10.3.4.
Z = depth of tensile zone in concrete section is less than 10 percent of section depth.

Bending Stiffness (EI) = Computed Bending Moment / Curvature.
Position of neutral axis is measured from edge of compression side of pile.
Compressive stresses and strains are positive in sign.
Tensile stresses and strains are negative in sign.

Axial Thrust Force = 0.000 kips

| Bending Max Concrete Curvature Stress rad/in. ksi | Bending Max Steel Moment Stress in-kip ksi | Bending Stiffness kip-in2 | Depth to N Axis in | Max Comp Strain in/in | Max Tens Strain in/in | Run Msg |
|---|---|---|---|---|---|---|
| 0.000001250 | 5.7633526 | 4610682. | 189.4093836 | 0.0005011 | 0.0002218 | |
| 1.1664551 | -132.2283701 | | | | | |
| 0.000002500 | 16.0758245 | 6430330. | 97.7092734 | 0.0005086 | 0.0002143 | |
| 1.2010630 | -132.4396561 | | | | | |
| 0.000003750 | 26.3880698 | 7036819. | 67.1448637 | 0.0005161 | 0.0002068 | |
| 1.2355864 | -132.6506971 | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 0.000005000 | 36.6999638 | 7339993. | 51.8643791 | 0.0005236 | 0.0001993 | 1.2700248 -132.8614928 |
| 0.000006250 | 47.0113817 | 7521821. | 42.6974646 | 0.0005312 | 0.0001919 | 1.3043778 -133.0720435 |
| 0.000007500 | 57.3221985 | 7642960. | 36.5873352 | 0.0005387 | 0.0001844 | 1.3386450 -133.2823490 |
| 0.000008750 | 67.6322895 | 7729405. | 32.2239402 | 0.0005463 | 0.0001770 | 1.3728259 -133.4924093 |
| 0.0000100 | 77.9415299 | 7794153. | 28.9522544 | 0.0005538 | 0.0001695 | 1.4069202 -133.7022244 |
| 0.0000113 | 88.2497947 | 7844426. | 26.4083746 | 0.0005614 | 0.0001621 | 1.4409273 -133.9117942 |
| 0.0000125 | 98.5569591 | 7884557. | 24.3739591 | 0.0005690 | 0.0001547 | 1.4748470 -134.1211189 |
| 0.0000138 | 108.8628982 | 7917302. | 22.7100633 | 0.0005766 | 0.0001473 | 1.5086786 -134.3301983 |
| 0.0000150 | 119.1674871 | 7944499. | 21.3240572 | 0.0005842 | 0.0001399 | 1.5424218 -134.5390324 |
| 0.0000163 | 129.4706009 | 7967422. | 20.1518126 | 0.0005918 | 0.0001325 | 1.5760762 -134.7476213 |
| 0.0000175 | 139.7721146 | 7986978. | 19.1475234 | 0.0005994 | 0.0001251 | 1.6096412 -134.9559647 |
| 0.0000188 | 150.0719032 | 8003835. | 18.2775987 | 0.0006070 | 0.0001177 | 1.6431166 -135.1640629 |
| 0.0000200 | 160.3698418 | 8018492. | 17.5168452 | 0.0006146 | 0.0001103 | 1.6765019 -135.3719156 |
| 0.0000213 | 170.6658048 | 8031332. | 16.8459974 | 0.0006223 | 0.0001030 | 1.7097965 -135.5795227 |
| 0.0000225 | 180.9596654 | 8042652. | 16.2500712 | 0.0006299 | 0.0000956 | 1.7430003 -135.7868837 |
| 0.0000238 | 191.2513020 | 8052686. | 15.7172369 | 0.0006376 | 0.0000883 | 1.7761126 -135.9939996 |
| 0.0000250 | 201.5405878 | 8061624. | 15.2380307 | 0.0006453 | 0.0000810 | 1.8091330 -136.2008699 |
| 0.0000263 | 211.8273975 | 8069615. | 14.8047917 | 0.0006529 | 0.0000736 | 1.8420611 -136.4074945 |
| 0.0000275 | 222.1116058 | 8076786. | 14.4112516 | 0.0006606 | 0.0000663 | 1.8748964 -136.6138734 |
| 0.0000288 | 232.3930874 | 8083238. | 14.0522323 | 0.0006683 | 0.0000590 | 1.9076386 -136.8200064 |
| 0.0000300 | 242.6717168 | 8089057. | 13.7234190 | 0.0006760 | 0.0000517 | 1.9402872 -137.0258936 |
| 0.0000313 | 252.9473686 | 8094316. | 13.4211868 | 0.0006837 | 0.0000444 | 1.9728418 -137.2315348 |
| 0.0000325 | 263.2199172 | 8099074. | 13.1424689 | 0.0006914 | 0.0000371 | 2.0053019 -137.4369300 |
| 0.0000338 | 273.4892371 | 8103385. | 12.8846526 | 0.0006992 | 0.0000299 | 2.0376671 -137.6420791 |
| 0.0000350 | 283.7552026 | 8107292. | 12.6454985 | 0.0007069 | 0.0000226 | 2.0699370 -137.8469820 |
| 0.0000363 | 294.0176922 | 8110833. | 12.4230762 | 0.0007146 | 0.0000153 | 2.1021110 -138.0516396 |
| 0.0000375 | 304.2765723 | 8114042. | 12.2157125 | 0.0007224 | 0.000008089 | 2.1341889 -138.2560500 |
| 0.0000388 | 314.5317192 | 8116948. | 12.0219502 | 0.0007302 | 0.000000851 | 2.1661701 -138.4602137 |
| 0.0000400 | 324.7827152 | 8119568. | 11.8405125 | 0.0007379 | -0.000006380 | 2.1980541 -138.6641331 |
| 0.0000413 | 335.0273043 | 8121874. | 11.6702660 | 0.0007457 | -0.0000136 | 2.2298380 -138.8678228 |
| 0.0000425 | 345.2629045 | 8123833. | 11.5102083 | 0.0007535 | -0.0000208 | 2.2615188 -139.0713019 |
| 0.0000438 | 355.4873696 | 8125426. | 11.3594539 | 0.0007613 | -0.0000280 | |

```
2.2930941  -139.2745852
 0.0000450   365.6988403      8126641.    11.2172167     0.0007691    -0.0000352
2.3245613  -139.4776863
 0.0000463   375.8956889      8127474.    11.0827968     0.0007769    -0.0000424
2.3559186  -139.6806177
 0.0000475   386.0765167      8127927.    10.9555691     0.0007847    -0.0000496
2.3871640  -139.8833900
 0.0000488   396.2401110      8128002.    10.8349734     0.0007925    -0.0000568
2.4182960  -140.0860131
 0.0000513   411.0078548      8019665.    10.5843508     0.0008067    -0.0000726
2.4746321  -140.5308118  C
 0.0000538   424.4265514      7896308.    10.3500412     0.0008206    -0.0000887
2.5290352  -140.9863349  C
 0.0000563   434.2028121      7719161.    10.1176640     0.0008334    -0.0001059
2.5788477  -141.4721491  C
 0.0000588   445.3473677      7580381.     9.9106239     0.0008465    -0.0001228
2.6295721  -141.9486533  C
 0.0000613   455.5629861      7437763.     9.7152280     0.0008594    -0.0001399
2.6786733  -142.4343342  C
 0.0000638   464.9662303      7293588.     9.5304069     0.0008719    -0.0001574
2.7262524  -142.9286461  C
 0.0000663   475.7923328      7181771.     9.3665415     0.0008848    -0.0001745
2.7752562  -143.4097280  C
 0.0000688   483.7485386      7036342.     9.1997534     0.0008968    -0.0001925
2.8200335  -143.9198874  C
 0.0000713   493.2655879      6923026.     9.0523337     0.0009093    -0.0002100
2.8665479  -144.4144842  C
 0.0000738   500.0787927      6780729.     8.9007164     0.0009207    -0.0002286
2.9088184  -144.9389110  C
 0.0000763   508.4876252      6668690.     8.7669374     0.0009328    -0.0002465
2.9530309  -145.4461783  C
 0.0000788   514.4402824      6532575.     8.6284804     0.0009438    -0.0002655
2.9931119  -145.9830086  C
 0.0000813   521.9289208      6423741.     8.5062767     0.0009554    -0.0002839
3.0352221  -146.5019321  C
 0.0000838   529.0330452      6316812.     8.3893111     0.0009669    -0.0003024
3.0764106  -147.0257672  C
 0.0000863   535.7789879      6211930.     8.2771847     0.0009782    -0.0003211
3.1167080  -147.5543744  C
 0.0000888   536.9020420      6049600.     8.1385311     0.0009866    -0.0003427
3.1462932  -148.1660570  C
 0.0000913   543.3230228      5954225.     8.0367057     0.0009976    -0.0003617
3.1852235  -148.7017215  C
 0.0000938   549.5386520      5861746.     7.9392114     0.0010086    -0.0003807
3.2235222  -149.2403235  C
 0.0000963   555.5696132      5772152.     7.8458092     0.0010195    -0.0003998
3.2612301  -149.7815938  C
 0.0000988   561.3945533      5685008.     7.7560125     0.0010302    -0.0004191
3.2982934  -150.3260266  C
 0.0001013   567.0280998      5600278.     7.6695991     0.0010408    -0.0004385
3.3347357  -150.8734924  C
 0.0001038   572.5252296      5518315.     7.5866513     0.0010514    -0.0004579
3.3706813  -151.4230246  C
 0.0001063   577.8859482      5438927.     7.5069106     0.0010619    -0.0004774
3.4061302  -151.9746653  C
 0.0001088   583.0503127      5361382.     7.4297246     0.0010723    -0.0004970
3.4409284  -152.5297516  C
 0.0001113   588.1230813      5286500.     7.3555771     0.0010826    -0.0005167
3.4753302  -153.0862026  C
 0.0001138   593.0555468      5213675.     7.2839394     0.0010928    -0.0005365
3.5092140  -153.6450831  C
 0.0001163   597.8561044      5142848.     7.2146683     0.0011030    -0.0005563
3.5425927  -154.2063311  C
```

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0.0001188 | 602.5839726 | 5074391. | 7.1479996 | 0.0011131 | -0.0005762 | 3.5756230 | -154.7686429 C |
| 0.0001213 | 607.1452961 | 5007384. | 7.0831234 | 0.0011231 | -0.0005962 | 3.6080494 | -155.3342608 C |
| 0.0001238 | 611.6772796 | 4942847. | 7.0208295 | 0.0011331 | -0.0006162 | 3.6402417 | -155.9000161 C |
| 0.0001263 | 616.0311061 | 4879454. | 6.9599559 | 0.0011430 | -0.0006363 | 3.6717884 | -156.4695378 C |
| 0.0001288 | 620.3757655 | 4818453. | 6.9015317 | 0.0011529 | -0.0006564 | 3.7031581 | -157.0387461 C |
| 0.0001313 | 624.5525696 | 4758496. | 6.8443418 | 0.0011626 | -0.0006767 | 3.7338997 | -157.6116629 C |
| 0.0001338 | 628.7183095 | 4700698. | 6.7893551 | 0.0011724 | -0.0006969 | 3.7644618 | -158.1843312 C |
| 0.0001363 | 632.7472773 | 4644017. | 6.7355908 | 0.0011820 | -0.0007173 | 3.7944751 | -158.7600879 C |
| 0.0001388 | 636.7423426 | 4589134. | 6.6836691 | 0.0011917 | -0.0007376 | 3.8242444 | -159.3362201 C |
| 0.0001413 | 640.6513424 | 4535585. | 6.6331236 | 0.0012012 | -0.0007581 | 3.8536089 | -159.9142109 C |
| 0.0001438 | 644.4838150 | 4483366. | 6.5839441 | 0.0012107 | -0.0007786 | 3.8825999 | -160.4938079 C |
| 0.0001463 | 648.2993660 | 4432816. | 6.5364540 | 0.0012203 | -0.0007990 | 3.9113974 | -161.0733714 C |
| 0.0001488 | 651.9771622 | 4383040. | 6.4897357 | 0.0012296 | -0.0008197 | 3.9396244 | -161.6564308 C |
| 0.0001588 | 666.2990593 | 4197159. | 6.3160840 | 0.0012670 | -0.0009023 | 4.0499103 | -163.9954215 C |
| 0.0001688 | 679.7930373 | 4028403. | 6.1592135 | 0.0013037 | -0.0009856 | 4.1553163 | -166.3526879 C |
| 0.0001788 | 692.6097866 | 3874740. | 6.0169252 | 0.0013398 | -0.0010695 | 4.2563081 | -168.7250804 C |
| 0.0001888 | 704.8861549 | 3734496. | 5.8875306 | 0.0013756 | -0.0011537 | 4.3533357 | -171.1092190 C |
| 0.0001988 | 716.6845546 | 3605960. | 5.7692916 | 0.0014109 | -0.0012384 | 4.4466063 | -173.5039229 C |
| 0.0002088 | 728.0547882 | 3487688. | 5.6607640 | 0.0014460 | -0.0013233 | 4.5362919 | -175.9082460 C |
| 0.0002188 | 739.0459816 | 3378496. | 5.5608096 | 0.0014807 | -0.0014086 | 4.6225765 | -178.3209816 C |
| 0.0002288 | 749.6845444 | 3277309. | 5.4683625 | 0.0015152 | -0.0014941 | 4.7055603 | -180.7417483 C |
| 0.0002388 | 759.9620084 | 3183087. | 5.3822640 | 0.0015493 | -0.0015800 | 4.7851874 | -183.1720121 C |
| 0.0002488 | 769.9952439 | 3095458. | 5.3024825 | 0.0015833 | -0.0016660 | 4.8619464 | -185.6065667 C |
| 0.0002588 | 779.8006207 | 3013722. | 5.2283743 | 0.0016171 | -0.0017522 | 4.9359212 | -188.0447611 C |
| 0.0002688 | 789.3008397 | 2936933. | 5.1586209 | 0.0016507 | -0.0018386 | 5.0067515 | -190.4918429 C |
| 0.0002788 | 798.6708008 | 2865187. | 5.0940191 | 0.0016843 | -0.0019250 | 5.0752261 | -192.9377552 C |
| 0.0002888 | 807.7539141 | 2797416. | 5.0327893 | 0.0017175 | -0.0020118 | 5.1406294 | -195.3927434 C |
| 0.0002988 | 816.7450765 | 2733875. | 4.9760476 | 0.0017509 | -0.0020984 | 5.2038544 | -197.8444179 C |
| 0.0003088 | 825.4682931 | 2673582. | 4.9219419 | 0.0017839 | -0.0021854 | 5.2640801 | -200.3052414 C |
| 0.0003188 | 834.1147715 | 2616831. | 4.8717094 | 0.0018172 | -0.0022721 | 5.3222036 | -202.7617180 C |
| 0.0003288 | 842.5477261 | 2562883. | 4.8238578 | 0.0018501 | -0.0023592 | 5.3775651 | -205.2245218 C |
| 0.0003388 | 850.8606880 | 2511766. | 4.7789273 | 0.0018832 | -0.0024461 | | |

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5.4306205  -207.6863972  C
 0.0003488   859.0847010      2463325.     4.7369193     0.0019163    -0.0025330
5.4814970  -210.1448357  C
 0.0003588   867.0881584      2416970.     4.6964433     0.0019491    -0.0026202
5.5295703  -212.6115560  C
 0.0003688   875.0148652      2372922.     4.6585916     0.0019822    -0.0027071
5.5755240  -215.0737671  C
 0.0003788   882.8631605      2330992.     4.6231635     0.0020153    -0.0027940
5.6193269  -217.5313930  C
 0.0003888   890.5153370      2290715.     4.5888906     0.0020482    -0.0028811
5.6604244  -219.9964151  C
 0.0003988   898.0778309      2252233.     4.5566405     0.0020813    -0.0029680
5.6993159  -222.4579815  C
 0.0004088   905.5608951      2215439.     4.5263777     0.0021145    -0.0030548
5.7360251  -224.9147819  C
 0.0004188   912.9551648      2180191.     4.4978895     0.0021478    -0.0031415
5.7704854  -227.3676533  C
 0.0004288   920.1726656      2146175.     4.4701784     0.0021809    -0.0032284
5.8023133  -229.8272667  C
 0.0004388   927.3094732      2113526.     4.4441309     0.0022142    -0.0033151
5.8319195  -232.2818733  C
 0.0004488   934.3637578      2082148.     4.4196440     0.0022476    -0.0034017
5.8592680  -234.7313691  C
 0.0004588   941.3336255      2051953.     4.3966237     0.0022813    -0.0034880
5.8843218  -237.1756457  C
 0.0004688   948.1990092      2022825.     4.3747779     0.0023150    -0.0035743
5.9069801  -239.6173548  C
 0.0004788   954.9203002      1994612.     4.3535927     0.0023486    -0.0036607
5.9271020  -242.0625011  C
 0.0004888   961.5551591      1967376.     4.3336746     0.0023824    -0.0037469
5.9448720  -244.5020743  C
 0.0004988   968.1014808      1941056.     4.3149567     0.0024164    -0.0038329
5.9602482  -245.9675865  C
 0.0005088   974.5570736      1915591.     4.2973780     0.0024506    -0.0039187
5.9731873  -247.1377931  C
 0.0005188   980.9196538      1890929.     4.2808826     0.0024850    -0.0040043
5.9836441  -248.1968296  C
 0.0005288   987.1868394      1867020.     4.2654194     0.0025196    -0.0040897
5.9915717  -249.1597519  C
 0.0005388   993.3269616      1843762.     4.2505268     0.0025543    -0.0041750
5.9968949  -250.0412364  C
 0.0005488   999.3529112      1821144.     4.2363599     0.0025890    -0.0042603
5.9996184  -250.8502574  C
 0.0006088  1032.5302814      1696148.     4.1721774     0.0028041    -0.0047652
5.9992364  -254.5565247  C
 0.0006688  1061.2633822      1586936.     4.1355443     0.0030299    -0.0052594
5.9950761  -257.0157617  C
 0.0007288  1086.2550267      1490573.     4.1182026     0.0032654    -0.0057439
5.9969149  -258.7689769  C
 0.0007888  1107.8982402      1404625.     4.1161221     0.0035109    -0.0062184
5.9962915  -260.0806251  C
 0.0008488  1121.6442805      1321525.     4.1134611     0.0037556    -0.0066937
5.9940649  -261.1194062  C
 0.0009088  1128.6938929      1242029.     4.1090192     0.0039984    -0.0071709
5.9973768  -261.9643736  C

--------------------------------------------------------------------------------
   Summary of Results for Nominal (Unfactored) Moment Capacity for Section 1
--------------------------------------------------------------------------------

Moment values interpolated at maximum compressive strain = 0.003
or maximum developed moment if pile fails at smaller strains.
```

| Load No. | Axial Thrust kips | Nominal Mom. Cap. in-kip | Max. Comp. Strain |
|---|---|---|---|
| 1 | 0.000 | 1057.453 | 0.00300000 |

Note note that the values of moment capacity in the table above are not factored by a strength reduction factor (phi-factor).

In ACI 318-08, the value of the strength reduction factor depends on whether the transverse reinforcing steel bars are tied hoops (0.65) or spirals (0.70).

The above values should be multiplied by the appropriate strength reduction factor to compute ultimate moment capacity according to ACI 318-08, Section 9.3.2.2 or the value required by the design standard being followed.

The following table presents factored moment capacities and corresponding bending stiffnesses computed for common resistance factor values used for reinforced concrete sections.

| Axial Load No. | Resistance Factor for Moment | Nominal Moment Capacity in-kip | Ultimate (Factored) Axial Thrust kips | Ultimate (Factored) Moment Capacity in-kip | Bending Stiffness at Ult. Mom. Cap. kip-in^2 |
|---|---|---|---|---|---|
| 1 | 0.65 | 1057.453 | 0.000 | 687.345 | 3937865.036 |
| 1 | 0.70 | 1057.453 | 0.000 | 740.217 | 3367354.861 |
| 1 | 0.75 | 1057.453 | 0.000 | 793.090 | 2907919.322 |

---

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 1

---

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 2600.000 lbs
Applied moment at pile head = 5200.000 in-lbs
Axial thrust load on pile head = 0.000 lbs

| Depth X feet | Deflect. y inches | Bending Moment in-lbs | Shear Force lbs | Slope S radians | Total Stress psi* | Bending Stiffness lb-in^2 | Soil Res. Es*h lb/inch | Soil Spr. p lb/in lb/inch | Distrib. Lat. Load |
|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 1.2926 | 5200.0000 | 2600.0000 | -0.008587 | 0.000 | 4.611E+09 | 0.000 | 0.000 | 0.000 |
| 0.200 | 1.2720 | 11440. | 2600.0000 | -0.008582 | 0.000 | 4.611E+09 | 0.000 | 0.000 | 0.000 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0.400 | 1.2514 | 17680. | 2600.0000 | -0.008576 | 0.000 | 6.562E+09 | 0.000 | 0.000 | 0.000 |
| 0.600 | 1.2309 | 23920. | 2600.0000 | -0.008569 | 0.000 | 6.932E+09 | 0.000 | 0.000 | 0.000 |
| 0.800 | 1.2103 | 30160. | 2600.0000 | -0.008560 | 0.000 | 7.169E+09 | 0.000 | 0.000 | 0.000 |
| 1.000 | 1.1898 | 36400. | 2600.0000 | -0.008549 | 0.000 | 7.333E+09 | 0.000 | 0.000 | 0.000 |
| 1.200 | 1.1693 | 42640. | 2600.0000 | -0.008536 | 0.000 | 7.454E+09 | 0.000 | 0.000 | 0.000 |
| 1.400 | 1.1488 | 48880. | 2600.0000 | -0.008521 | 0.000 | 7.547E+09 | 0.000 | 0.000 | 0.000 |
| 1.600 | 1.1284 | 55120. | 2600.0000 | -0.008505 | 0.000 | 7.621E+09 | 0.000 | 0.000 | 0.000 |
| 1.800 | 1.1080 | 61360. | 2600.0000 | -0.008486 | 0.000 | 7.680E+09 | 0.000 | 0.000 | 0.000 |
| 2.000 | 1.0876 | 67600. | 2600.0000 | -0.008466 | 0.000 | 7.729E+09 | 0.000 | 0.000 | 0.000 |
| 2.200 | 1.0673 | 73840. | 2600.0000 | -0.008444 | 0.000 | 7.770E+09 | 0.000 | 0.000 | 0.000 |
| 2.400 | 1.0471 | 80080. | 2600.0000 | -0.008421 | 0.000 | 7.806E+09 | 0.000 | 0.000 | 0.000 |
| 2.600 | 1.0269 | 86320. | 2600.0000 | -0.008395 | 0.000 | 7.836E+09 | 0.000 | 0.000 | 0.000 |
| 2.800 | 1.0068 | 92560. | 2600.0000 | -0.008368 | 0.000 | 7.862E+09 | 0.000 | 0.000 | 0.000 |
| 3.000 | 0.9868 | 98800. | 2600.0000 | -0.008339 | 0.000 | 7.885E+09 | 0.000 | 0.000 | 0.000 |
| 3.200 | 0.9668 | 105040. | 2600.0000 | -0.008308 | 0.000 | 7.906E+09 | 0.000 | 0.000 | 0.000 |
| 3.400 | 0.9469 | 111280. | 2600.0000 | -0.008275 | 0.000 | 7.924E+09 | 0.000 | 0.000 | 0.000 |
| 3.600 | 0.9271 | 117520. | 2600.0000 | -0.008240 | 0.000 | 7.940E+09 | 0.000 | 0.000 | 0.000 |
| 3.800 | 0.9073 | 123760. | 2600.0000 | -0.008204 | 0.000 | 7.955E+09 | 0.000 | 0.000 | 0.000 |
| 4.000 | 0.8877 | 130000. | 2600.0000 | -0.008166 | 0.000 | 7.968E+09 | 0.000 | 0.000 | 0.000 |
| 4.200 | 0.8681 | 136240. | 2600.0000 | -0.008126 | 0.000 | 7.981E+09 | 0.000 | 0.000 | 0.000 |
| 4.400 | 0.8487 | 142480. | 2600.0000 | -0.008084 | 0.000 | 7.992E+09 | 0.000 | 0.000 | 0.000 |
| 4.600 | 0.8293 | 148720. | 2600.0000 | -0.008040 | 0.000 | 8.002E+09 | 0.000 | 0.000 | 0.000 |
| 4.800 | 0.8101 | 154960. | 2600.0000 | -0.007994 | 0.000 | 8.011E+09 | 0.000 | 0.000 | 0.000 |
| 5.000 | 0.7910 | 161200. | 2600.0000 | -0.007947 | 0.000 | 8.020E+09 | 0.000 | 0.000 | 0.000 |
| 5.200 | 0.7719 | 167440. | 2600.0000 | -0.007898 | 0.000 | 8.027E+09 | 0.000 | 0.000 | 0.000 |
| 5.400 | 0.7531 | 173680. | 2600.0000 | -0.007847 | 0.000 | 8.035E+09 | 0.000 | 0.000 | 0.000 |
| 5.600 | 0.7343 | 179920. | 2600.0000 | -0.007794 | 0.000 | 8.042E+09 | 0.000 | 0.000 | 0.000 |
| 5.800 | 0.7156 | 186160. | 2600.0000 | -0.007740 | 0.000 | 8.048E+09 | 0.000 | 0.000 | 0.000 |
| 6.000 | 0.6971 | 192400. | 2600.0000 | -0.007683 | 0.000 | 8.054E+09 | 0.000 | 0.000 | 0.000 |
| 6.200 | 0.6788 | 198640. | 2600.0000 | -0.007625 | 0.000 | 8.059E+09 | 0.000 | 0.000 | 0.000 |
| 6.400 | 0.6605 | 204880. | 2600.0000 | -0.007565 | 0.000 | 8.064E+09 | 0.000 | 0.000 | 0.000 |
| 6.600 | 0.6424 | 211120. | 2600.0000 | -0.007503 | 0.000 | 8.069E+09 | | | |

```
0.000       0.000       0.000
     6.800      0.6245     217360.   2600.0000  -0.007439       0.000  8.074E+09
0.000       0.000       0.000
     7.000      0.6067     223600.   2600.0000  -0.007374       0.000  8.078E+09
0.000       0.000       0.000
     7.200      0.5891     229840.   2600.0000  -0.007306       0.000  8.082E+09
0.000       0.000       0.000
     7.400      0.5717     236080.   2600.0000  -0.007237       0.000  8.085E+09
0.000       0.000       0.000
     7.600      0.5544     242320.   2600.0000  -0.007166       0.000  8.089E+09
0.000       0.000       0.000
     7.800      0.5373     248560.   2600.0000  -0.007093       0.000  8.092E+09
0.000       0.000       0.000
     8.000      0.5203     254800.   2600.0000  -0.007019       0.000  8.095E+09
0.000       0.000       0.000
     8.200      0.5036     261040.   2600.0000  -0.006942       0.000  8.098E+09
0.000       0.000       0.000
     8.400      0.4870     267280.   2600.0000  -0.006864       0.000  8.101E+09
0.000       0.000       0.000
     8.600      0.4706     273520.   2600.0000  -0.006784       0.000  8.103E+09
0.000       0.000       0.000
     8.800      0.4545     279760.   2600.0000  -0.006702       0.000  8.106E+09
0.000       0.000       0.000
     9.000      0.4385     286000.   2600.0000  -0.006618       0.000  8.108E+09
0.000       0.000       0.000
     9.200      0.4227     292240.   2600.0000  -0.006533       0.000  8.110E+09
0.000       0.000       0.000
     9.400      0.4071     298480.   2600.0000  -0.006445       0.000  8.112E+09
0.000       0.000       0.000
     9.600      0.3917     304720.   2600.0000  -0.006356       0.000  8.114E+09
0.000       0.000       0.000
     9.800      0.3766     310960.   2600.0000  -0.006265       0.000  8.116E+09
0.000       0.000       0.000
    10.000      0.3617     317200.   2600.0000  -0.006172       0.000  8.118E+09
0.000       0.000       0.000
    10.200      0.3470     323440.   2600.0000  -0.006078       0.000  8.119E+09
0.000       0.000       0.000
    10.400      0.3325     329680.   2600.0000  -0.005981       0.000  8.121E+09
0.000       0.000       0.000
    10.600      0.3183     335920.   2600.0000  -0.005883       0.000  8.122E+09
0.000       0.000       0.000
    10.800      0.3043     342160.   2600.0000  -0.005782       0.000  8.123E+09
0.000       0.000       0.000
    11.000      0.2905     348400.   2600.0000  -0.005680       0.000  8.124E+09
0.000       0.000       0.000
    11.200      0.2770     354640.   2600.0000  -0.005577       0.000  8.125E+09
0.000       0.000       0.000
    11.400      0.2637     360880.   2600.0000  -0.005471       0.000  8.126E+09
0.000       0.000       0.000
    11.600      0.2507     367120.   2600.0000  -0.005363       0.000  8.127E+09
0.000       0.000       0.000
    11.800      0.2380     373360.   2600.0000  -0.005254       0.000  8.127E+09
0.000       0.000       0.000
    12.000      0.2255     379600.   2600.0000  -0.005143       0.000  8.128E+09
0.000       0.000       0.000
    12.200      0.2133     385840.   2600.0000  -0.005030       0.000  8.128E+09
0.000       0.000       0.000
    12.400      0.2014     392080.   2600.0000  -0.004915       0.000  8.128E+09
0.000       0.000       0.000
    12.600      0.1897     398320.   2600.0000  -0.004798       0.000  8.112E+09
0.000       0.000       0.000
    12.800      0.1783     404560.   2600.0000  -0.004679       0.000  8.066E+09
0.000       0.000       0.000
```

```
    13.000     0.1673    410800.  2600.0000  -0.004558      0.000  8.021E+09
0.000      0.000      0.000
    13.200     0.1565    417040.  2591.0293  -0.004433      0.000  7.963E+09
-7.4756   114.6665      0.000
    13.400     0.1460    423237.  2562.9827  -0.004306      0.000  7.907E+09
-15.8966   261.3561      0.000
    13.600     0.1358    429342.  2514.1488  -0.004176      0.000  7.805E+09
-24.7983   438.2749      0.000
    13.800     0.1259    435305.  2443.8308  -0.004042      0.000  7.705E+09
-33.8000   644.1561      0.000
    14.000     0.1164    441073.  2352.3948  -0.003905      0.000  7.632E+09
-42.3966   874.2027      0.000
    14.200     0.1072    446596.  2240.9211  -0.003765      0.000  7.562E+09
-50.4981  1130.6756      0.000
    14.400     0.0983    451829.  2111.2634  -0.003621      0.000  7.489E+09
-57.5499  1404.7501      0.000
    14.600     0.0898    456730.  1965.7286  -0.003475      0.000  7.419E+09
-63.7292  1703.1224      0.000
    14.800     0.0816    461265.  1806.4558  -0.003326      0.000  7.349E+09
-68.9981  2028.2987      0.000
    15.000     0.0738    465401.  1650.0772  -0.003174      0.000  7.289E+09
-61.3174  1992.9568      0.000
    15.200     0.0664    469185.  1519.5035  -0.003020      0.000  7.249E+09
-47.4940  1716.4646      0.000
    15.400     0.0593    472695.  1406.1004  -0.002863      0.000  7.213E+09
-47.0086  1901.0603      0.000
    15.600     0.0527    475934.  1294.9747  -0.002705      0.000  7.179E+09
-45.5962  2077.9598      0.000
    15.800     0.0464    478911.  1188.1147  -0.002545      0.000  7.123E+09
-43.4538  2249.4987      0.000
    16.000     0.0404    481637.  1086.1961  -0.002383      0.000  7.074E+09
-41.4784  2461.2226      0.000
    16.200     0.0349    484125.   990.0930  -0.002218      0.000  7.032E+09
-38.6076  2653.1042      0.000
    16.400     0.0298    486390.   901.8797  -0.002052      0.000  7.004E+09
-34.9036  2811.1399      0.000
    16.600     0.0251    488454.   823.4140  -0.001885      0.000  6.979E+09
-30.4845  2917.9693      0.000
    16.800     0.0208    490342.   755.2077  -0.001716      0.000  6.957E+09
-26.3542  3048.1011      0.000
    17.000     0.0168    492079.   694.1090  -0.001547      0.000  6.937E+09
-24.5614  3501.6592      0.000
    17.200     0.0133    493674.   638.0159  -0.001376      0.000  6.914E+09
-22.1829  3995.0726      0.000
    17.400     0.0102    495141.   590.0434  -0.001204      0.000  6.883E+09
-17.7942  4174.7801      0.000
    17.600   0.007547    496506.   552.2582  -0.001031      0.000  6.854E+09
-13.6935  4354.4876      0.000
    17.800   0.005282    497792.   523.8506  -0.000856      0.000  6.827E+09
-9.9795  4534.1952      0.000
    18.000   0.003437    499020. -7737.4951  -0.000681      0.000  6.802E+09
-6874.4752   4800000.      0.000
    18.200   0.002015    460652.    -20822.  -0.000518      0.000  7.358E+09
-4029.5848   4800000.      0.000
    18.400   0.000953    399073.    -27945.  -0.000383      0.000  8.106E+09
-1905.8827   4800000.      0.000
    18.600   0.000175    326516.    -30651.  -0.000276      0.000  8.120E+09
-349.3056   4800000.      0.000
    18.800  -0.000372    251948.    -30177.  -0.000190      0.000  8.094E+09
744.0347   4800000.      0.000
    19.000  -0.000739    181664.    -27510.  -0.000126      0.000  8.043E+09
1478.7761   4800000.      0.000
    19.200  -0.000977    119899.    -23392. -8.076E-05      0.000  7.946E+09
```

```
1953.3313   4800000.      0.000
    19.400  -0.001127     69385.    -18343. -5.190E-05      0.000  7.742E+09
2254.0641   4800000.      0.000
    19.600  -0.001226     31854.    -12696. -3.585E-05      0.000  7.219E+09
2451.5489   4800000.      0.000
    19.800  -0.001299  8444.2258 -6636.2682 -2.866E-05      0.000  5.362E+09
2598.2006   4800000.      0.000
    20.000  -0.001363      0.000      0.000 -2.677E-05      0.000  4.611E+09
2726.7089   2400000.      0.000
```

* This analysis makes computations of pile response using nonlinear moment-curvature relationships.
  The above values of total stress are computed for combined axial and bending stress in elastic
  sections and do not equal actual stresses in concrete and steel in the range of nonlinear bending.

Output Summary for Load Case No. 1:

```
Pile-head deflection             =      1.2926327 inches
Computed slope at pile head      =     -0.0085867 radians
Maximum bending moment           =        499020. inch-lbs
Maximum shear force              =        -30651. lbs
Depth of maximum bending moment  =    216.0000000 inches below pile head
Depth of maximum shear force     =    223.2000000 inches below pile head
Number of iterations             =             17
Number of zero deflection points =              1
```

---

Pile-head Deflection vs. Pile Length for Load Case 1

---

Boundary Condition Type 1, Shear and Moment

```
Shear      =           2600. lbs
Moment     =           5200. in-lbs
Axial Load =              0. lbs
```

| Pile Length feet | Pile Head Deflection inches | Maximum Moment ln-lbs | Maximum Shear lbs |
|---|---|---|---|
| 20.0000 | 1.2926327 | 499020. | -30651. |
| 19.0000 | 2.2000804 | 472666. | -57864. |

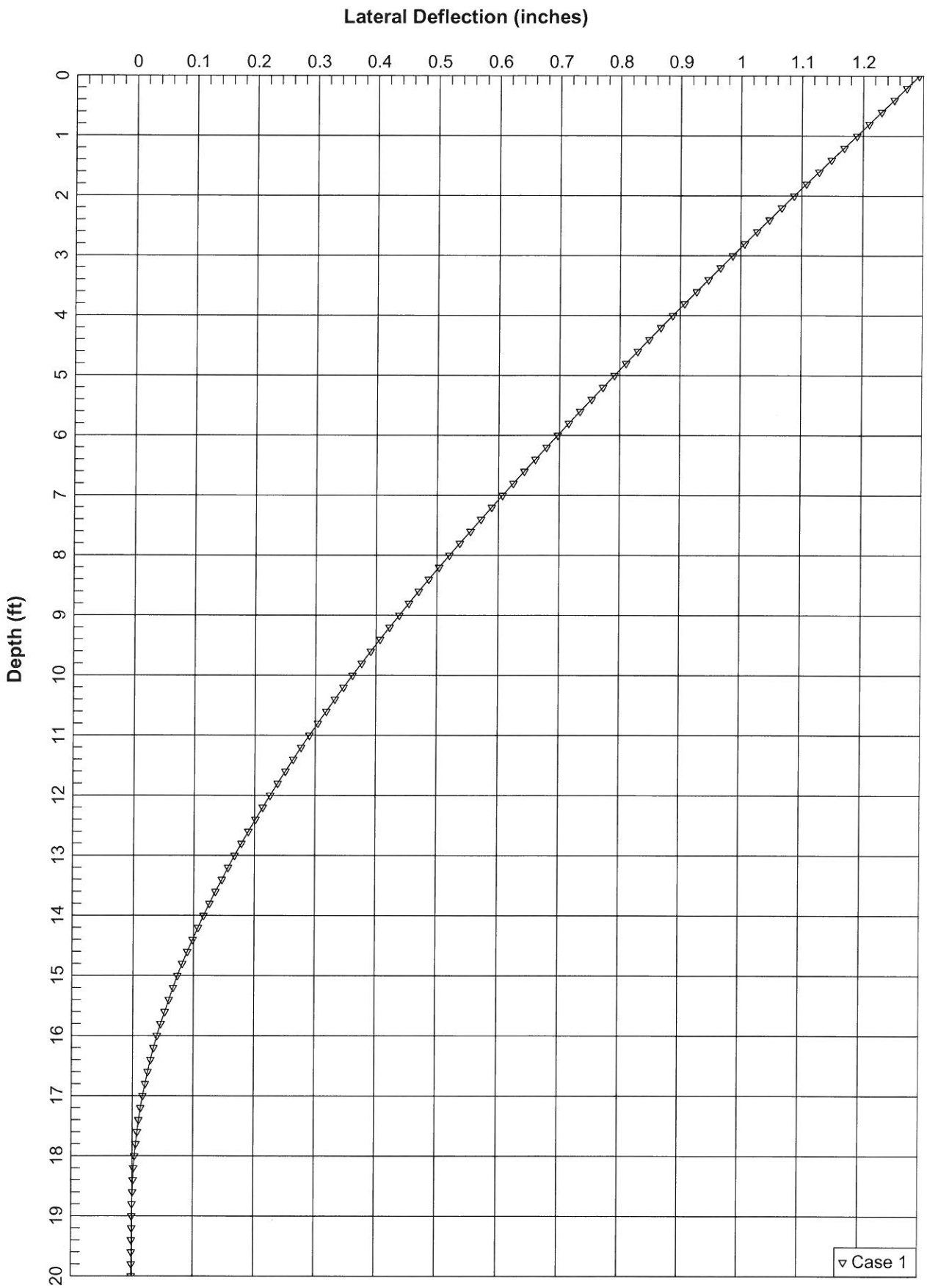
---

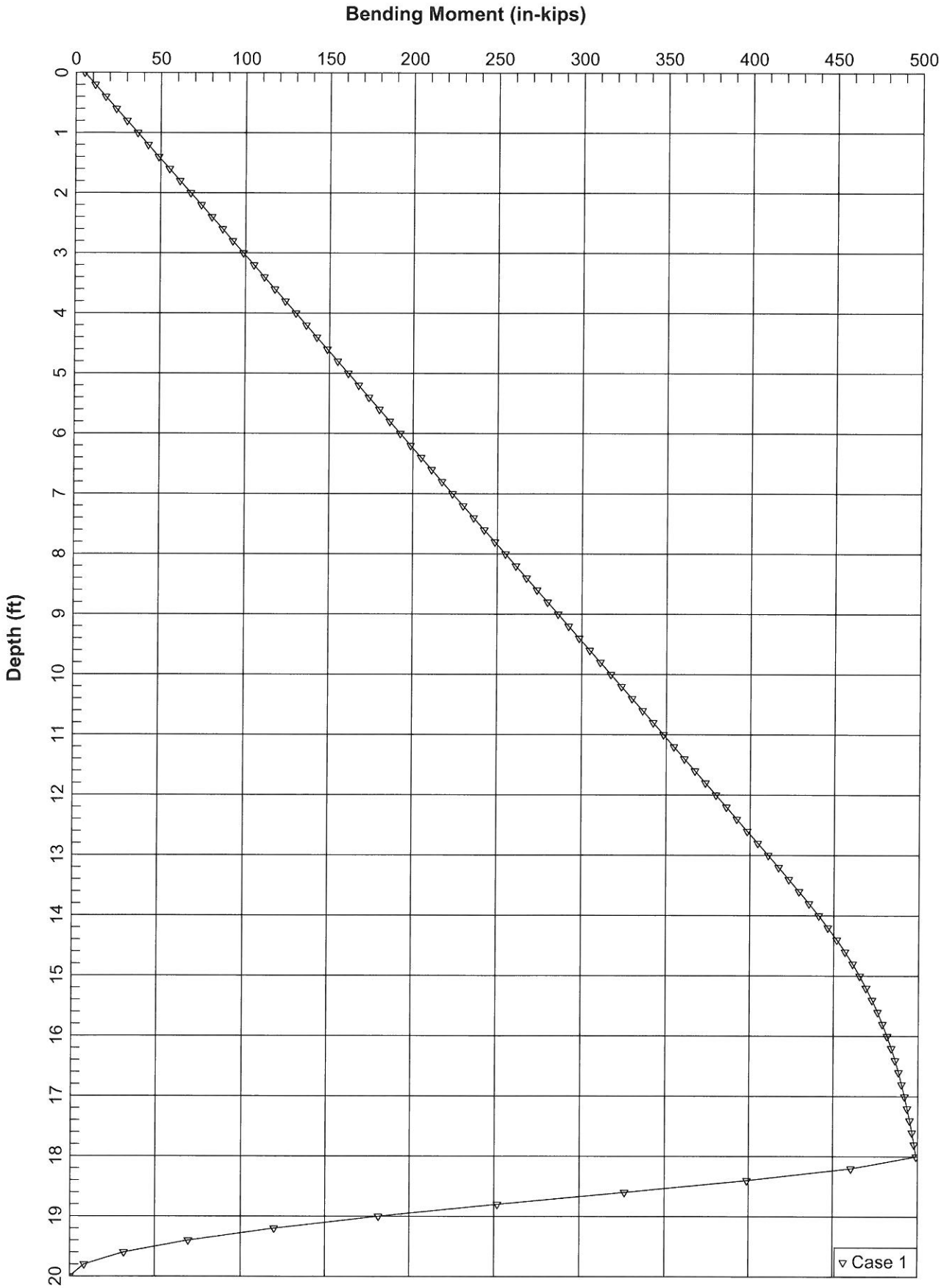
Summary of Pile Response(s)

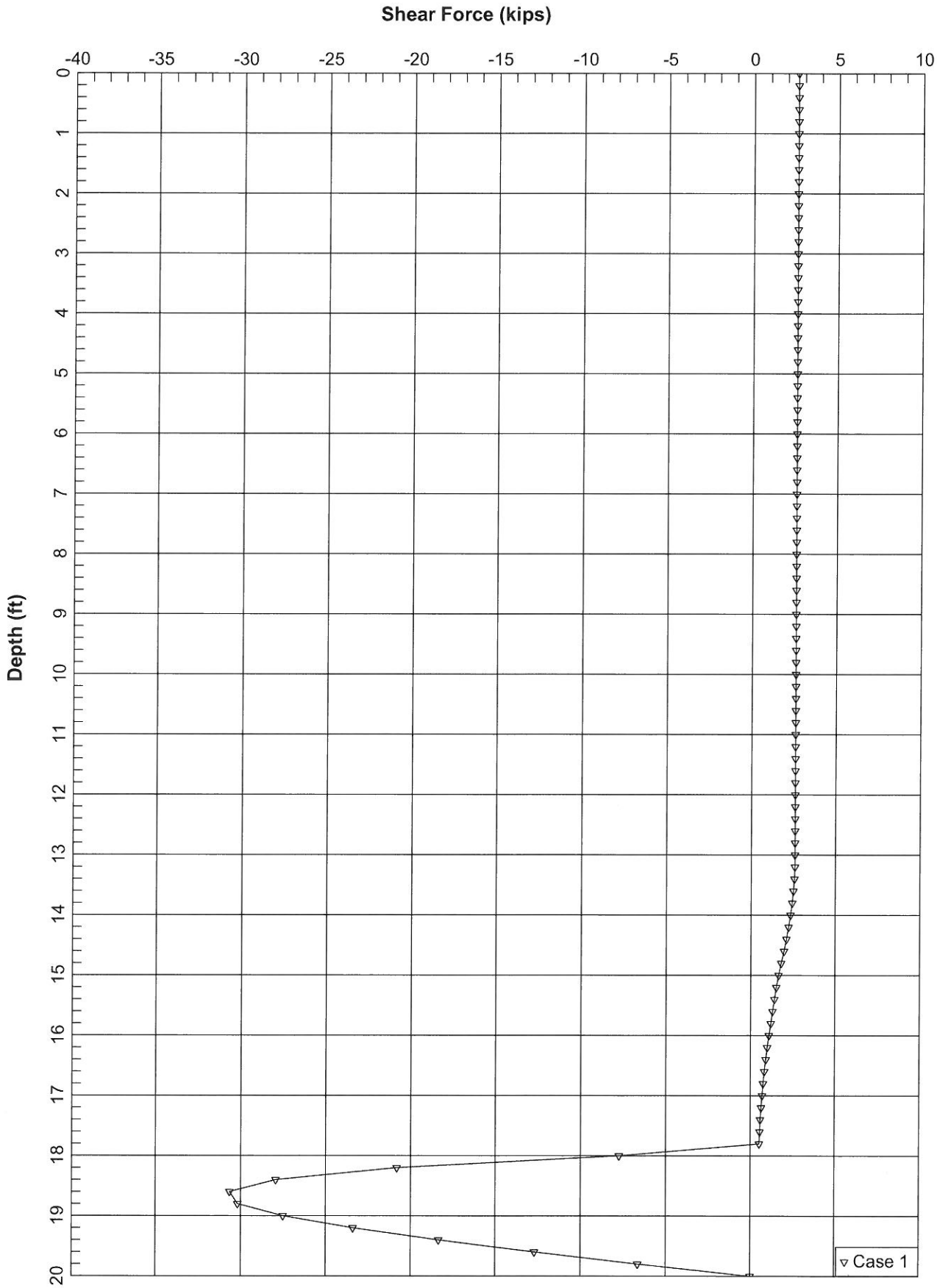
---

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians


Lateral Deflection (inches)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Case 1


Bending Moment (in-kips)
0
50
100
150
200
250
300
350
400
450
500
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Case 1


Shear Force (kips)
-40
-35
-30
-25
-20
-15
-10
-5
0
5
10
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Case 1

## 7. SUMMARY AND RECOMMEDATIONS

The survey located all of the existing intermediate and terminal bents and with top of cap elevation. A total of 37 intermediate and terminal bents were located. The intermediate and terminal bents were superimposed on an aerial photo of the original pedestrian walkway. The survey also shows the extent of the man-made earthen berm and the edge of water. The survey also located the vegetation on the berm for eventual permitting purposes.

The intermediate and terminal bents were all observed to be founded on 12 in. square, precast and prestressed concrete piles. The visual inspection of the accessible bents did not detect any damage or cracks to the piles. Furthermore, no anomalies in the PIT readings which would suggest damage below surface were noted during the PIT testing.

The axial capacity of the piles was determined using the Florida Bridge Software Institute Shaft and Pile Analysis (FB-Deep v. 2.04). An estimate of available capacity was made for full embedment capacity. Pile embedment varied along the length of the walkway, depending on the location of the bent. It was assessed that the piles located away from the berm and located within the bay may have minimal embedment. Critical pile capacity was determined on the basis of natural ground embedment only. No capacity was assigned to those portions of the piles embedded within the overlying fill layers (berm). A net critical axial allowable capacity of **8 tons** was obtained.

The lateral capacity of the piles was determined by first assessing the maximum allowable bending capacity of the piles. The allowable lateral load was then limited to the load that produced the maximum allowable bending capacity on the piles. A series of LPILE analyses were performed to determine the maximum allowable lateral load. A maximum allowable lateral load of **1.3 tons**, applied to the top of the concrete bent cap, was determined.

**The reconstruction of the walkway superstructure should be designed to limit the vertical load on the existing 12 in. sq. piles to an allowable load of 8 tons and an allowable lateral load of 1.3 tons applied to the top of the cap.**