COUNTY PURCHASING AGENT

Fort Bend County, Texas

Jaime Kovar
County Purchasing Agent

(281) 341-8640
Fax (281) 341-8645

May 13, 2024

TO: All Prospective Bidders

RE: Addendum No. 1 – Fort Bend County BID 24-059 – Construction of African American Memorial Phase One for Fort Bend County

Addendum 1:

Attached is addendum 1. Vendors are to utilize Addendum 1 document while preparing their solicitation response. Changes include Q&A#1, Geotechnical report, and GFRC Specifications Provided by Architect.

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Immediately upon your receipt of this addendum, please fill out the following information and email this page to Tyler Kendziora at tyler.kendziora@fortbendcountytx.gov

____
Company Name

____
Signature of person receiving addendum Date

If you have any questions, please contact this office.

Sincerely,

Tyler Kendziora

Tyler Kendziora
Senior Buyer

Bid 24-059 – African American Memorial Phase One for Fort Bend County

Q&A #1

Question 1: Please provide the contact information for the structural consultant.

Answer: CDI – Otis Jones, ojones@coredesignimpact.com

Question 2: Please issue the Geotechnical Report

Answer: Provided and attached.

Question 3: Please provide contacts information for Precast Concrete Suppliers/Subcontractors.

Answer:

1. *Reference sheet A203, specifications Part 2 - Products for contact information to precast supplier (Locke Solutions).*
2. *2nd Option: Pretecsa, pretecsa@pretecsa.com | (55) 5077 0070*

Question 4: Please provide specifications for GFRC.

Answer: Provided and attached.

Question 5: Please provide contacts information for GFRC Suppliers/Subcontractors.

Answer: Supplier:

1. *GFRC Cladding: John M. Foy | jfoy@gfrc.us | 972-837-5004*
2. *Innovative Cast Inc.: Nesha Solesa | nesha@innovativecast.com | 416-277-7160*

Answer: Sub-Contractors:

1. *Duffin Architectural Solutions: Wyatt Duffin, wyatt@duffinarchitecturalsolutions.com | 512-508-4549*

Question 6: Please provide additional information for the GFRC Alternate – foundation design, primary structural steel design, etc. My concern would be many GFRC suppliers typically do no provide the primary steel components – they would just picked the secondary structural steel parts that are integral to their work and exclude the primary structural steel.

Answer: GFRC Specification has been duly provided. Contractors expressing interest in undertaking this scope of work are required to adhere to the stipulations outlined herein. It is incumbent upon the contractor submitting a bid for this scope to include a comprehensive design package, encompassing both delegated design and fully engineered design components. This includes, but is not limited to, the provision of detailed shop drawings pertaining to the GFRC cladding system, *alongside the associated steel attachment system, for thorough review and subsequent approval.*

Delegated design submissions will undergo a thorough review by the architect to ensure alignment with the prevailing design parameters. Furthermore, engineered drawings must bear the signature and seal of a structural engineer duly licensed in the state of Texas, thereby affirming compliance with local regulatory requirements and standards.

Question 7: To expedite the pricing process with highest degree of accuracy, is it possible to issue the 3D models for the monument pillars?

Answer: No. the county website doesn't support these file types.

Question 8: Do you have the contact information for CDI? I have tried to look them up, but I haven't found anything for them.

Answer: See Response to Question 1.

Question 9: Is there a specific company you have been working with for the precast vertical monuments?

Answer: Reference question 3.

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ATL Project # G22-201

Report
Geotechnical Investigation
Proposed AA Memorial @ Bates Allen Park
Phase I, Charlie Roberts Lane
Fort Bend County, Texas

Prepared For

Fort Bend County Parks & Recreation Dept.
5855 Sienna Springs Way
Missouri City, Texas 77459

January 25, 2023

ASSOCIATED TESTING LABORATORIES

3143 Yellowstone Blvd., Houston, Texas 77054
Tel: (713) 748-3717 Fax: (713) 748-3748

January 25, 2023
Project No: G22-201

Ms. Gwendolyn Climmons, JD
Special Project Manager
Fort Bend County Parks & Recreation Department.
Sienna Annex- Suite 149
5855 Sienna Springs Way
Missouri City, Texas 77459

Reference: Geotechnical Investigation
Proposed AA Memorial @ Bates Allen Park
Phase I, Charlie Roberts Lane
Fort Bend County, Texas

Dear Ms. Climmons, JD:

Associated Testing Laboratories, Inc. is pleased to present our report for the above referenced project. This report summarizes our investigations, analyses and recommendations for design and construction of the project.

Once you are ready for construction, we will be pleased to assist you in field / laboratory testing of materials and construction inspection.

It has been a pleasure working with you on this project. If you have any question regarding this report, please contact us. We look forward to being of further assistance as construction begins.

Very truly yours,

ASSOCIATED TESTING LABORATORIES, INC.
(TBPE Firm Registration No. F-4560)

Nutan V Palla, Ph.D., P.E.
Director of Geotechnical Services

STATE OF TEXAS
NUTAN V. PALLA
110176
LICENSED
PROFESSIONAL ENGINEER

Nutan
1.25.23

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Introduction

General

This report presents the results of a geotechnical investigation performed by Associated Testing Laboratories, Inc. (ATL) for Fort bend County Parks & Recreation Department. The location of the project site is shown in Figure 1. This report includes ATL's Investigations and geotechnical recommendations for the design and construction of this project.

Project Description

Information for this project was provided by Ms. Gwendolyn Climmons, JD with Fort bend County Parks & Recreation Department. The proposed Phase I and one- story Building Phase 2 project is located at Charlie Robert Lane, Fort Bend County, Texas. The project site is currently an open lot with grass and some trees, relatively flat, with topographic variations of about 1 to 2 feet.

Scope of Work

The purpose of this geotechnical investigation is to explore and evaluate the subsurface conditions for developing geotechnical design and construction recommendations. ATL's scope of services included performing the following tasks:

- Review available geologic and geotechnical data pertinent to the project site.
- Investigate the subsurface conditions by drilling and sampling four (4) geotechnical borings to depths of approximately 20-ft & 40-ft below the ground surface with a drill rig, in accordance with ASTM Standards.
- Perform geotechnical laboratory tests on selected soil samples obtained from the borings in accordance with ASTM Standards.
- Perform engineering analyses and geologic evaluation.
- Prepare this report containing ATL's investigations and recommendations, which includes following:
  a) Discussion of the surface and subsurface geotechnical conditions and site preparation.
  b) Recommendations for type and depth of foundations for structural support.
  c) Pavement Recommendations
  d) Construction monitoring.

Field Exploration

The field exploration consisted of drilling and sampling of a total of four (4), two (2) 20-ft- & two (2) 40-ft deep soil borings, 120 linear feet. The approximate boring locations are shown in Figure 1.

Proposed Improvements	Number of Borings	Boring Depth (ft)	Total Drilling Footage (ft)
Monument Phase I	2	40	80
Learning Center Phase II	2	20	40
Total			120

The boreholes were drilled and sampled under the observations of our experienced geotechnical engineering technician and performed in accordance with ASTM Standards. The field drilling was performed with a truck mounted drilling rig and was advanced using dry auger method.

Soil samples were obtained continuously to a depth of 20-ft and thereafter 5-ft interval. Undisturbed samples of cohesive soils were obtained from the borings by pushing 3.0-inch diameter thin-wall, seamless steel Shelby tube samplers. Strength of the cohesive soils are estimated in the field using a hand penetrometer. The undisturbed samples of cohesive soils were extruded mechanically from the core barrels in the field and wrapped in aluminum foil. All soil samples were inspected and classified and sealed in plastic bags to reduce moisture loss and disturbance. The samples were placed in core boxes and transported to the laboratory for further testing.

Standard Penetration Test (SPT) were performed in low cohesion (silts) and cohesionless sands. We recorded the driving resistance while performing the SPT. The samples were placed in sealed bags and delivered to our laboratory

The borings were drilled using dry auger methods until groundwater or caving sands were encountered. At that point, the borings were completed using wash-rotary drilling techniques. The groundwater levels were monitored for 15 minutes prior to completing the borings.

The boreholes were backfilled with soil cuttings upon completion of drilling. Subsurface information from the soil borings are presented in the individual Boring Logs in Appendix A.

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Laboratory Testing

Laboratory testing were performed on selected representative soil samples collected during the field investigation to measure physical and engineering properties. The types of laboratory tests are shown in the following table.

Type of Test	Testing Method
Natural Water Content	ASTM D 2216
Atterberg Limits	ASTM D 4318
Sieve Analysis No. 200	ASTM D 1140
Unconfined Compression	ASTM 2166
Soil Classification	ASTM D2487
One Dimensional Consolidation Test	ASTM D 2435

Description of the laboratory tests:

- ***Moisture Content of Soil –***. The moisture content of the soil (in percentage) is defined as the ratio of the mass of fluid to the mass of soil solid. The moisture content can provide an indication of cohesive soil plastic state of cohesive soils.

- ***Atterberg Limits (Liquid Limit, Plastic Limit and Plasticity Index).*** These tests are used for soil plasticity (high, low or non) and provide an indication of volume change potential when considered in conjunction with the natural moisture content. The liquid limit and plastic limit establish the boundaries of the consistency states of plastic soils. The difference between the liquid limit and the plastic limit is defined as plastic index.

- ***Sieve Analysis No. 200 (75-μm) Sieve –***. This test measures the total amount of material (in percentage) in soils finer than the No. 200 sieve.

- ***Unconfined Compressive Strength of Cohesive Soil –***. This test measures the unconfined compressive strength of cohesive soils in undisturbed or remolded condition, using strain-controlled deformation under load application. The undrained shear strength of a cohesive soil sample is one-half of the unconfined compressive strength.

- ***One-dimensional, incremental loading consolidation testing is performed on intact cohesive soil samples.*** The procedure involves incrementally loading test specimens to a pressure of about 58 tsf using a load increment. The duration of each load is maintained until primary consolidation is complete, as determined by the deformation-log time slope. The test specimens are unloaded using a load decrement. The test includes an unload reload hysteresis loop. The specimen deformation for each load is presented as a plot that can be used to evaluate soil compressibility parameters for estimating settlements.

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The results of the laboratory tests are presented on the test boring logs and the test summary sheets and test reports in Appendix A.

The consolidation test results are summarized in the following table.

One Dimensional Consolidation Test Results

Boring	Depth Range	Po' (psf)	Pc (psf)	Cc	Cr	e_o	Moisture (%)	Dry Dens. (pcf)	LL	PI	SQD
B-1	18-20		18300	0.1303	0..016	0.373	11.5	122.8			A
B-2	12-14		13000	0.141	0.018	0.444	17.5	116.4			A

Sample Quality Designation (SQD) (Terzaghi et al. 1996)		Δe/e0 Criteria (Lunne et al. 1997)		
Volumetric Strain (%)	SQD	OCR = 1-2 Δe/e0	OCR = 2-4 Δe/e0	Rating
<1	A	<0.04	<0.030	Very good to excellent
1 – 2	B	0.04-0.07	0.03 – 0.05	Good to Fair
2 – 4	C	0.07-0.14	0.05 – 0.10	Poor
4 - 8	D	>0.14	>0.10	Very Poor
> 8	E	-	-	-

Subsurface and Site Conditions

Site Geology

The site is underlain by the Beaumont Formation of Pleistocene age. This formation consists of over consolidated clays, silts and sands with some shell calcium carbonate and iron oxides. These formations are quite strong and extend to an approximate depth of 100 feet. The surface materials are often weakened by the weathering process.

There are numerous faults and fault systems in the Greater Houston and surrounding areas. The movement of many of these faults has been affected in recent history by area subsidence. The subsidence is caused by removal of oil and ground water. As much as nine feet of subsidence has taken place in the eastern part of Houston in the last seventy years, and more than five feet of that has taken place in the last decade as demand for oil and water has increased. Conversion to surface water usage and the limiting of oil production has greatly reduced the subsidence rate in the east of Houston. However, continued ground water withdrawal in the southwest Houston area makes subsidence and associated faulting a continuing problem in that area.

An investigative fault study is beyond the scope of this study. For a geologic fault risk evaluation of this project site, we recommend consulting a professional geologist knowledgeable in geological faults in the Harris and Montgomery County area.

Soil Conditions

Two (2) 40-ft & two (2) 20-ft deep borings were drilled within the proposed Phase 1 , Monument location and Phase 2 one (1) story learning center buildings. Based on the soil borings drilled, the surface soils in the proposed area consist of a surface stratum of stiff to hard, medium to high plasticity Sandy Lean Clay (CL) soil to a depth varying from 13 to 23 feet. These Soils are underlain by Medium dense to dense, non-plastic Silty Sand (SM) extending to the maximum depth of 40 feet.

Clay soils with higher plasticity have a considerable shrink/swell potential due to seasonal moisture variations, and often contain slickensides as a result of the shrink/swell movements. A more detailed description of the subsurface soils and stratigraphy may be found on the boring logs in Appendix A.

Groundwater

The test borings were drilled using dry auger methods to obtain free water level measurements. The following table summarizes the depths where groundwater was observed while drilling and the depths after 15 minutes of observations.

Boring No	Boring Depth	Dry Auguring Depth	Ground water Depth		
			While Auguring	After 15 min	EOD Readings
B-1	40	20	20	26	23.9
B-2	40	20	20	26	24
B-3	20	20	20	Dry	Dry
B-4	20	20	20	Dry	Dry

Sands and silts, and clay stratum containing considerable lenses/seams/layers of more permeable soils such as silty/clayey sand or sandy silt, can become pathways for water infiltration during rain events and form perched water. The rate of flow of groundwater produced by these layers will depend upon the weather conditions such as amount of precipitation and ambient temperature etc., at the time of construction. It should also be noted that the groundwater level is generally influenced by such factors as topography and surface drainage features.

It should be noted that a detailed hydro-geological investigation of the proposed project area is beyond the scope of this investigation. Groundwater depths measured during and at completion of drilling are shown on the respective boring logs.

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General Site Preparation Guidelines

Site Preparation

Areas to be cut or filled should be stripped to remove organic materials, and other deleterious materials to expose competent soils. Generally, the depth of stripping should be on the order of 4 in. The stripped materials should not be used as compacted fill. If encountered, loose or wet soils should be undercut and replaced with compacted backfill.

The ground surface should be appropriately graded throughout construction to prevent ponding of rainfall runoff and provide positive drainage.

Proof Rolling

The effective depth of proof rolling will depend on the vehicle weight and tire pressures. We recommend that proof rolling be performed using earthmoving equipment such as loaders and scrapers, compactors, or tracked vehicles.

Proof rolling should extend at least 5 ft beyond the construction limits and should include overlapping perpendicular passes in two directions. The proof rolling specifications should provide for the following acceptance criteria:

Rut depths less than 2 inches
No visual evidence of pumping

A geotechnical representative should be present to observe and document each proof rolling and to delineate areas of weak or compressible soils. Areas that are not in compliance with the proof rolling specifications could require remediation. Remedial options include disking and air drying, application of geogrid reinforcement, and chemical treatment.

Select Fill

For areas such as below floor slabs and below soil supported foundations such as spread footings, the select fill should meet the following specifications.

Item	Specification	Test Reference
soil fines	More than 60% passing No. 200 sieve and less than 85%	ASTM D 1140
plasticity index (PI)	10 to 20	ASTM D 4318
liquid limit	less than 40	ASTM D 4318
classification	CL	ASTM D 2487 & 2488
organic content	less than 4 percent	ASTM D 2974
Compaction	95% of max. Standard Proctor	ASTM D 698
Moisture Content	±2	ASTM D 2216

The fill should be placed in uniform layers or lifts. Typically, a maximum 8 in. lift thickness (loose measure) is appropriate for most conventional compactors. The fill should be compacted to at least 95 percent of the maximum dry density determined by the Standard Proctor test (ASTM D 698). The water content should be at or above the optimum water content.

Lime Stabilization

Subgrade soils for pavements, driveways, and access roads should be lime stabilized to a depth of at least 8 inches to reduce the tendency for shrinking and swelling and to improve all-weather access. The following outlines the suggested procedures for lime stabilization.

The lime or lime slurry used should meet the TXDOT specifications for Type A or Type B hydrated lime or lime slurry. The supplier should provide certificates that the lime meets these specifications. The volume of soil to be stabilized should be verified each day by measurement of length, width, and thickness. The geotechnical engineer should perform in-place field density tests to calculate the soil dry weight. The contractor should survey and stake the limits of the area to be lime treated and provide weight tickets to confirm that the required weight of lime was added.

The lime stabilizer should be added and blended into the soil with a pulvimixer capable of mixing the entire layer thickness. During the mixing process, water should be added as needed to maintain the soil lime mixture at a minimum of 2% above the optimum moisture content, based on ASTM D 698 test procedures. The layer surface should then be sealed with a rubber tired roller and left to mellow for about 48 hours or as evaluated during mixing. The surface should be kept moist with a water truck.

During the above mixing and prior to sealing, the soil and lime should be well blended and the maximum particle size of the blend should not exceed 1 in. Prior to sealing, the pH of the mixture should be checked to confirm that the pH is at least 12.4

After the mellowing period, the stabilized soil should be remixed, conditioned to at least 2% above the optimum moisture content and compacted to a minimum dry density of 95% per ASTM D-698. The surface of the compacted subgrade should be sealed each day and maintained in a moist condition until pavement components are placed.

The optimum lime content should be determined by testing during construction. For budgeting purposes, we estimate the optimum lime content to be on the order of 6% lime by dry weight of soil.

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Foundation Recommendations

Spread Footings

The individual spread footings should be founded in the stiff to very stiff Sandy Lean Clay (CL) soils at a depth of about 4-ft below the existing ground elevation. The depth of the stiff clays could vary.

The individual spread footings should be designed for an allowable bearing capacity of 3,000 psf total loads. This bearing capacity is based on a minimum safety factor of 3.0. If allowed by the design code, the net allowable bearing pressures can be increased by ⅓ for transient loads. The bearing pressures could be limited by settlement.

We expect the settlement of the footing size (8-ft x 8-ft) or equivalent area with net sustained load (2500 psf) will be about 1-in. We need to perform settlement analysis for the footing size larger than 8-ft by 8-ft.

For best results, the foundation soils after excavation should be tamped using a portable compactor and standing water (if any) should be pumped out and footings poured immediately after the excavation has been made.

The allowable capacity of an individual spread footing to resist net uplift loads can be determined from the following equations, the smaller value of Equation (1) or (2) shall governs:

$$Q_u = 5.8\ c\ (B * L) / FS1 + W_{ftg} / FS2 \qquad (1)$$

$$W_{ftg + Soil} = [(B*L) + (B+Z)*(L+Z)] / 2 * Z * 100 / FS2 \qquad (2)$$

Where:

	Q_u	=	Allowable uplift capacity, pounds
	C	=	Average shear strength above the footing grade, pounds per square foot. (use c = 250 PSF)
	B	=	Width of individual spread footing, feet.
	L	=	Length of individual spread footing, feet.
	FS1	=	Factor of safety, use 2.0
	W_{ftg}	=	Weight of spread footing, lbs.
	FS2	=	Factor of safety, use 1.1
	$W_{ftg + Soil}$	=	Weight of soil wedge above spread footing and the weight of footing, lbs.
	Z	=	Depth of top of spread footing from ground surface, ft.

Drilled and Underreamed Cast-in-Place Concrete Piers

Monument Phase I

Drilled piers should be bottomed at a depth of Eighteen (18) feet below the existing grade. Drilled piers should be designed for net allowable bearing pressure of 5400 psf. The net allowable bearing pressure can be increased by 1/3 for transient loads, if allowed by design code.

Learning Center Phase II

Drilled piers should be bottomed at a depth of twelve (12) feet below the existing grade. Drilled piers should be designed for net allowable bearing pressure of 4500 psf. The net allowable bearing pressure can be increased by 1/3 for transient loads, if allowed by design code.

We anticipate the foundation settlement of the drilled piers of the footing size (8-ft x 8-ft) or equivalent area with net sustained load will be less than ½ -in. We need to perform settlement analysis for the footing size larger than 8-ft by 8-ft.

The lateral response of the straight or underream piers will be function to the depth, dimension and shaft diameter, as well as, reinforcing steel and concrete compressive strength. The response will also be a function of the head conditions (free and fixed) for the underream and the elevation where lateral loads are applied. once final size has be selected, we can perform lateral analysis, if needed.

The ultimate capacity of underreamed footings to resist uplift loads can be determined from the following equation provided the ratio of footing depth to bell diameter:

$$Qu = 5.8 * c * (D^2 - d^2)$$

Where:

Q_u	=	Ultimate uplift capacity, lbs
c	=	Average shear strength above the footing grade, pounds per square foot (Use c = 500 psf)
D	=	Underream diameter, feet
d	=	Shaft diameter, feet

We recommend a minimum factor of safety of 2.0 for uplift capacity in the final design. The depth of the surface crack can be taken as 3-ft if the area adjoining the structure is not paved. Surface cracking can be neglected if paving, or a permanent impervious cover, adjoins the entire structure periphery. A factor of safety of 3 should be used to calculate the allowable uplift resistance. The weight of the foundation can be added to the uplift resistance and can be calculated by using a unit weight of 150 pcf.

The drilled piers should be wide enough for cleaning and inspection purposes. Each pier should be provided with sufficient vertical steel reinforcement extending from the top to within six inches of the bottom of the piers to resist tension stresses created by lateral and uplift forces. To resist uplift forces the underreams should be at least one foot larger than the shaft to serve as an anchor. The drilled footings should be designed with an underream/shaft ratio of up to 3:1.

If material at the belling depth sloughs during underreaming, the problem can usually be alleviated by increasing the belling angle or by increasing the diameter of the shaft portion of the footing. If sloughing persists, it may become necessary to reduce underream to shaft ratio to 2:1 or use straight-sided shafts. For best results, any standing water should be pumped out and footings poured immediately after the excavation is competed.

Grade Beams

Grade beams used in conjunction with drilled piers should be designed to support the imposed loads and bear directly on the soil. We recommend that grade beams with a minimum depth of 18 in. be placed beneath all exterior and interior load-bearing walls. It is our experience that void boxes below grade beams can deteriorate and provide access for water that can cause soil swelling.

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Deep Foundations

Straight, 18-in, 24 in and 30-in diameter drilled shafts are being considered for support of Monument building to resist overturning and lateral loads. These foundations resist compressive and uplift forces in addition to overturning moments and lateral loads.

ATL neglected the top 5-ft of the soils below the existing grade in our drilled shaft capacity computation to account for weathering effects and potential incidental excavations. It should be noted the tension capacity is based solely on soil/pile interaction. Piles and pile cap connections should be structurally capable of resisting design uplift loads.

We estimated the ultimate and allowable axial compression and tension capacities for drilled, straight shaft foundations for 18-in, 24-in, 30-in and 36-in diameters as shown on Figures 2 and 3. The ultimate and allowable axial capacities were computed in general agreement with the methodology recommended by publication FHWA No. IF-99-025 implemented in the computer code SHAFT (Ensoft, Inc.). Allowable compression includes a safety factor of 2.5 and 3.0 for skin friction and end bearing respectively. Allowable tension includes a safety factor of 3.0. We excluded weight of the concrete in tension capacity. The buoyant weight of the concrete can be added using a factor of safety 1.2

For deep foundations, lateral loads are resisted by the soil as well as the rigidity of the shaft. Lateral capacity will vary with foundation type and properties, degree of fixity and spacing. Typically, lateral loads are analyzed using the p-y method in which the soil is modeled as a series of non-linear springs. This procedure with appropriate computer codes (i.e., LPILE by Ensoft, Inc.) has the advantage that major factors influencing soil resistance are inherently included in the semi-empirical p-y design criteria.

The lateral response input parameters are shown below. The results obtained using LPile software will be unfactored. The structural engineer should use an applicable factor of safety.

Depth below existing grade (ft)	Soil Layer	*Total Unit wt. (pcf)	Cohesion (psf)	Friction Angle (Φ)	Modulus (pci)	Strain Factor (ε_{50})
0-6	Stiff Clay w/o free water	120	1200	-	-	0.007
6-23	Stiff Clay w/o free water	130	3000	-	-	0.007
23-40	Sand	68	-	40	120	-

**groundwater at 23 ft;*

The structural engineer should decide the final shaft size, penetration depth and steel reinforcement based on axial and lateral capacity. We will incorporate these analyses in a separate addendum report.

Drilled Shaft Group Effects

Group Capacity: In situations where the design load is too high for a single drilled shaft/pile, drilled shaft/pile groups may be installed. The efficiency of a shaft/pile group is the ratio of the actual group capacity to the sum of the individual shaft axial capacities. The group efficiency factors are shown in Figure 5.

Groups of piles having a center-to-center spacing of less than three (3) diameters should be analyzed for axial group efficiency. We should be contacted to analyze group capacities and settlements once the final pile size, depth loads, and group configurations are selected.

Lateral Response - Pile Group

The single pile lateral capacity is impacted by group effects and reductions in single pile capacities will be necessary for group effects for pile spacing ranging up to approximately 6 diameters.

The lateral group efficiency factor (Ge) is approximately equal to the average value of the Pm values shown below for all piles in the group. For instance, for a 3 by 3 pile group with a center-to-center spacing of 3 diameters, the lateral group efficiency will be about 0.69 [-(0.82 + 0.68 + 0.58)/3].

Recommended Pm Values for Square & Rectangular Pile Layout Patterns

Pile Spacing (center-to-center)	Leading Row	1st Trailing Row	2nd Trailing Row	3rd and Subsequent Trailing Rows
3 Diameters	0.82	0.68	0.58	0.52
4 Diameters	0.90	0.78	0.72	0.68
5 Diameters	0.94	0.89	0.86	0.84
6 Diameters	1.0	1.0	1.0	1.0

When evaluating the lateral capacity of a pile group, the passive resistance and sliding friction against the pile cap can be considered in addition to the lateral capacity of the piling.

We can analyze lateral pile group response to the specific loading case, pile configuration and location using 2-dimensional (2D) routine of the program Group Version 2016 (Ensoft, 2016). The pile response interaction is modeled by the computer internally-generated axial (t-z and q-z) and lateral (p-y) curves based on the input soil parameters. The analysis is performed using internally-generated "cyclic" p-y curves. Lateral group effects are considered by internal routines based on the pile spacing and pile location within the group (i.e., "leading pile" and "trailing" piles). The effects of pile cap embedment are also evaluated.

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Drilled Shaft Foundation Settlement

Settlement of the drilled shaft/driven pile foundations will consist of the deformation of the shaft material and the foundation soils due to load transfer along the shaft/soil interface and below the tip of the shaft. Estimated settlement can be calculated as follows:

$$S = Ws + PL/AE \qquad \text{(i.e. PL/AE – Elastic Shortening)}$$

Where:

Ws = Settlement of the foundation caused by the consolidation of the underlying soils due to load transfer at the tip and along the shaft/pile.

P = Total axial load
L = Length of foundation
A = Cross-sectional area of the shaft
E = Modulus of elasticity of the shaft

For drilled shaft foundations designed using the allowable capacity curves presented in Figure 2, the Ws component of the settlement is presented in Figure 3 respectively.

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Concrete Paving

The pavement designs presented below based on the use of 4,000 PSI portland cement concrete (PCC) with a Modules of Rupture of about 660 PSI. The following pavement subgrade preparation and stabilization sequence is recommended:

1. Remove existing vegetation and topsoil and excavate to the design grade and proof-roll the pavement subgrade as recommended in the "Site Preparation" section.

2. Once the pavement subgrade has been prepared and graded to the design grade, the top 8 inches of the subgrade soils and should be scarified and treated with about 6 to 8 percent lime (on weight basis) and compacted at a moisture content within +/- 2 percent of optimum to at least 95 percent of the maximum dry density of the Standard Proctor (ASTM D 698).

The following pavement sizes are recommended:

Light Vehicles	Medium Vehicles	Heavy Vehicles
6" PCC	7" PCC	8" PCC
8" Stabilized Subgrade	8" Stabilized Subgrade	8" Stabilized Subgrade

Note: Typical commercial type traffic is assumed. If high volume heavy truck traffic is anticipated, ATL shall be informed and a pavement design based on the forecast traffic loading and frequency shall be performed.

The pavement designs presented in this report are based on the following load classifications:

Design Loads	Gross Vehicle Weight
Light	6,000 pounds
Medium	10,000 pounds
Heavy	20,000 pounds

Pavement Maintenance

It is essential to maintain the pavement to prevent infiltration of water into the subgrade soils. Allowing water into the subgrade will accelerate pavement failure and maintenance requirements. Periodic maintenance must be performed on the pavement sections to seal any surface cracks and prevent infiltration of water

Foundation Construction

Placement of concrete should be accomplished as soon as possible to prevent changes in state of stress and caving of the foundation soils. Excavation/drilling of foundations should be inspected by an ATL representative or soil engineer to help assure the integrity of foundations.

Design Review

It is recommended that ATL be allowed to review the design and construction plans and specifications prior to release to make sure that the geotechnical recommendations and design criteria presented herein have been properly interpreted.

Limitations

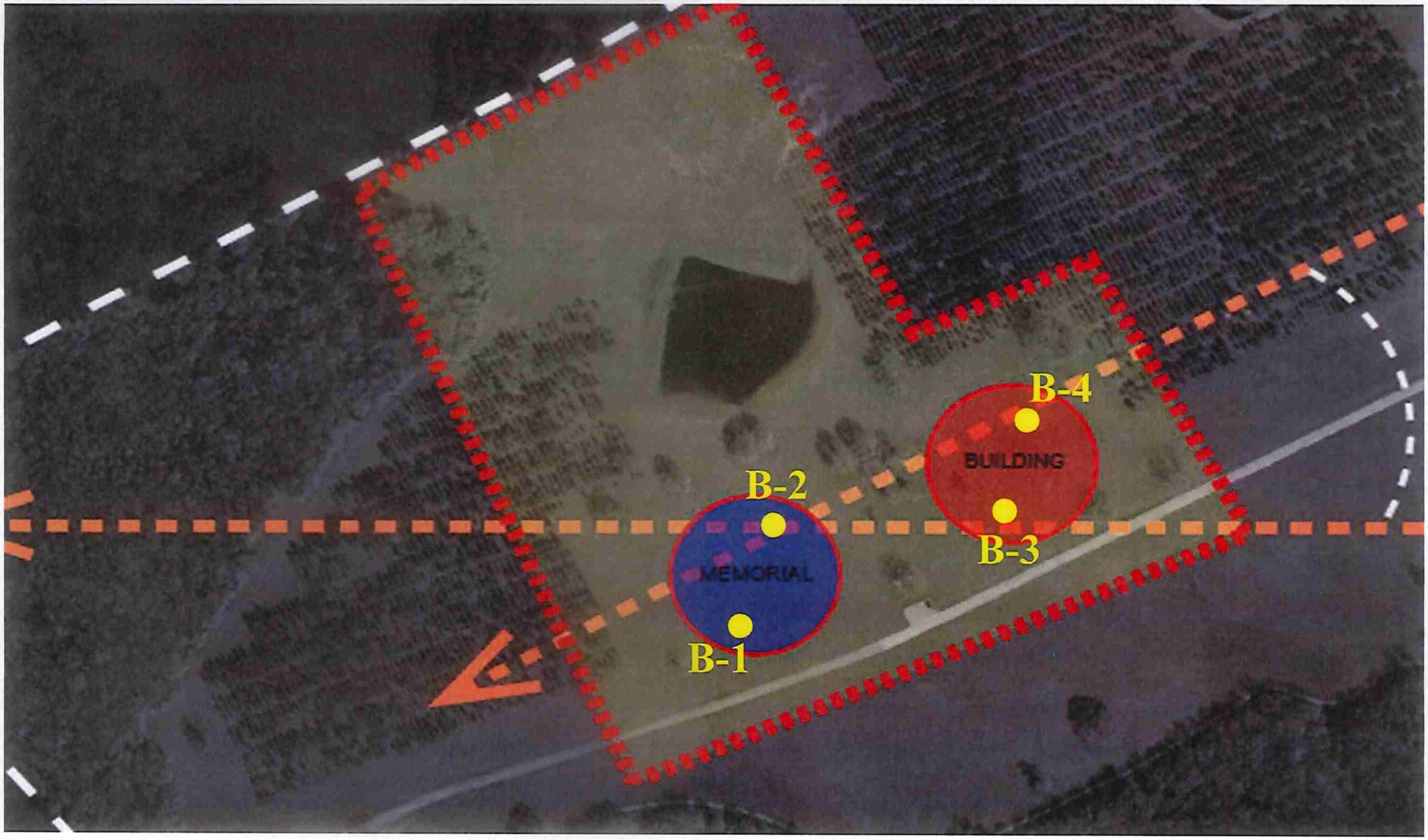
Information in this report is based on data obtained from test borings at the locations shown in Figure 1, selected laboratory tests, and professional interpretation and evaluation of such data considering the project information furnished. A description of expansive soils is presented in Appendix B; this appendix also presents the recommendations to properly maintain the foundation.

If the soil conditions change significantly from those discussed in this report, our office should be notified immediately so that an evaluation and any necessary adjustments can be made. Also, if the scope of the project changes significantly, our office should be notified. Analyses of slope stability, bulkhead or any other features at this site are not within the scope of this investigation and, therefore, ATL is not responsible for any problems caused by these features. Also the recommendations given in this report may not be valid if conditions such as leakage of underground pipes, leaking of pools, standing of water occur at the site. ATL is not responsible for any problems caused by these features. This report also does not consider the effect of deep tree roots that may be present on the site.

References

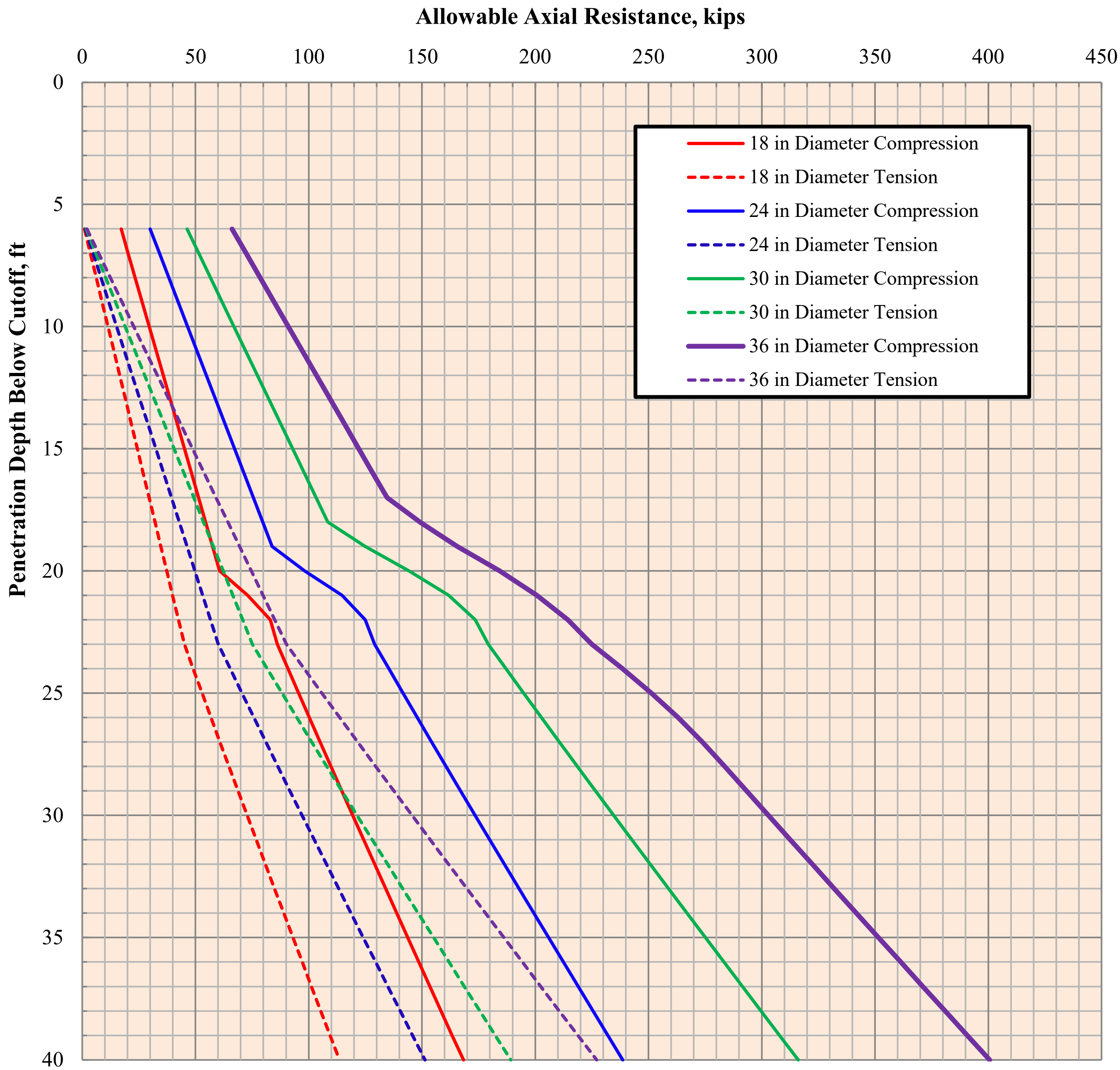
1. Joseph E. Bowles (1982), "Foundation Analysis and Design," 3rd ed., McGraw-Hill Book Company.
2. Braja M. Das (1985), "Principles of Geotechnical Engineering," PWS Engineering.
3. Merlin G. Spangler and Richard L. Handy (1982)," Soil Engineering, Fourth Edition, Harper & Row Publishers.
4. Alfreds R. Jumikis (1971), "Foundation Engineering," Intext Educational Publishers.
5. W.L. Schroeder (1980), "Soils in Construction," Second Edition, John Wiley & Sons.
6. Annual Book of ASTM Standards for Soils and Rock; Building Stones.
7. Harris County Soil Survey; USDA Soil Conservation Services.
8. Geologic Atlas of Texas, Bureau of Economic Geology, The University of Texas.
9. Groundwater Quality in Texas; Texas Natural Resources Conservation Commission.
10. OSHA 29 CFR PART 1926.
11. Greater Houston Waste Water Program Guidelines.
12. Yang H. Huang (1993), "Pavement Analysis and Design," Prentice Hall.
13. E.J. Yoder and M.W. Witczak (1975), "Principles of Pavement Design," John Wiley & Sons, Inc., Second Edition
14. Design of Pavement Structure, AASHTO 1993.

Figures



BORINGS:
B-1 & B-2 at 40-ft deep
B-3 & B-4 at 20-ft deep

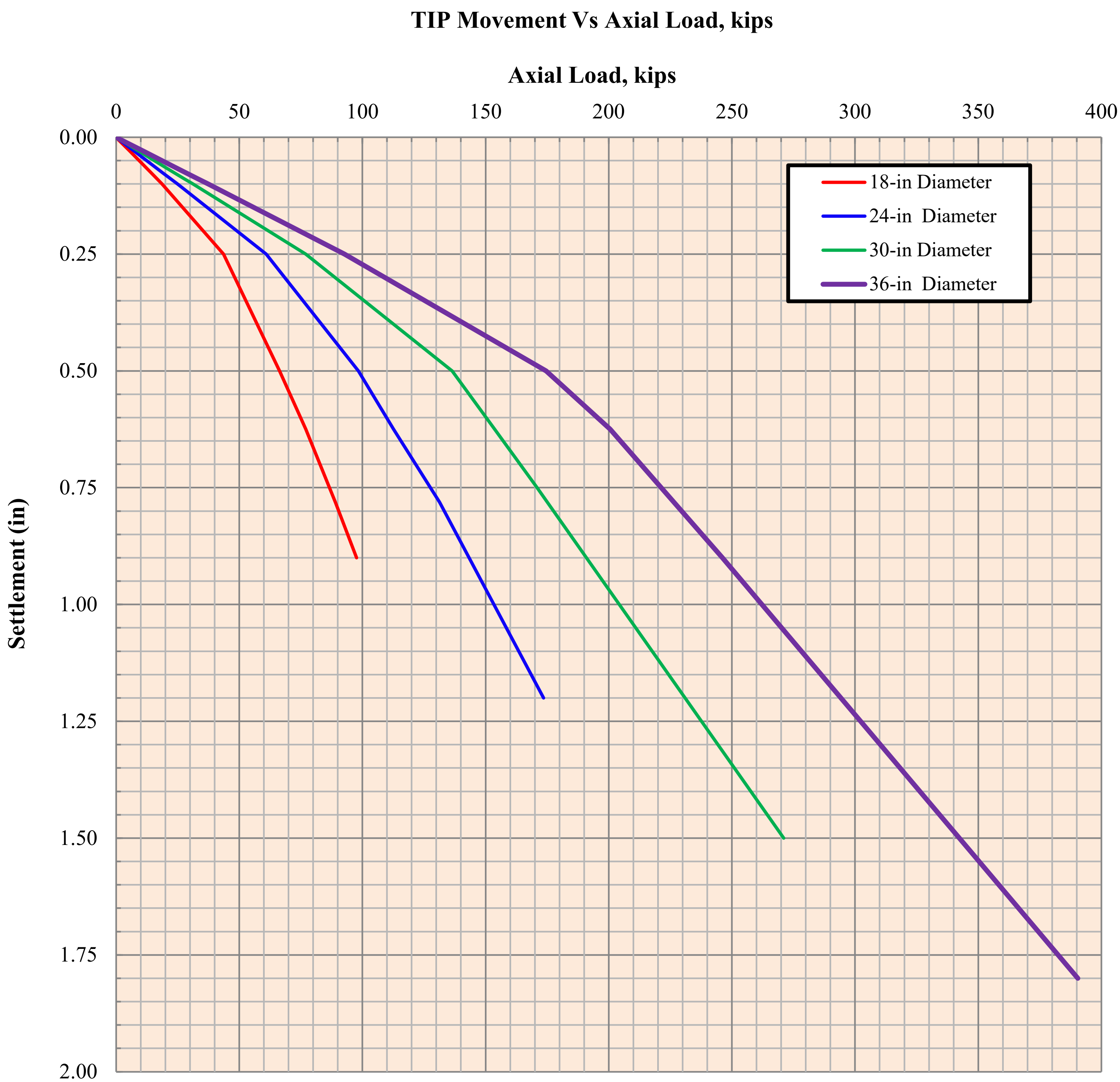
Proposal: AA Memorial @ Bates Allen Park, Fort Bend County, Texas	ASSOCIATED TESTING LABORATORIES	Project No.:G22-201
		Not to Scale
Client: Forth Bend County, Texas	Proposed Boring Location Plan	FIGURE 1



Notes:

1. Based on information from Project Borings B-1 & B-2.
2. Allowable side resistance for compression loading includes safety factor of 2.5 for skin friction and 3.0 for end bearing.
3. Allowable resistance for tension loading includes safety factor of 3.0.
4. Drilled Shaft cutoff assumed at existing grade.
5. We discounted soil frictional resistance to about 5-ft.

Project: Proposed AA Memorial @ Bates Allen Park Fort Bend County, Texas	ASSOCIATED TESTING LABORATORIES	Project Number: G22-201
Client: Fort Bend County Parks & Recreation Dept. Missouri City, Texas	**18-in to 36-in Diameter Drilled Shaft_ Monument**	Figure 2



Notes:

1. Based on information from Project Borings B-1 & B-2.
2. No factor of safety was applied

Project: Proposed AA Memorial @ Bates Allen Park Fort Bend County, Texas	ASSOCIATED TESTING LABORATORIES	Project Number: G22-201
Client: Fort Bend County Parks & Recreation Dept. Missouri City, Texas	**18-in to 36-in Diameter Drilled Shaft_ Monument**	Figure 3

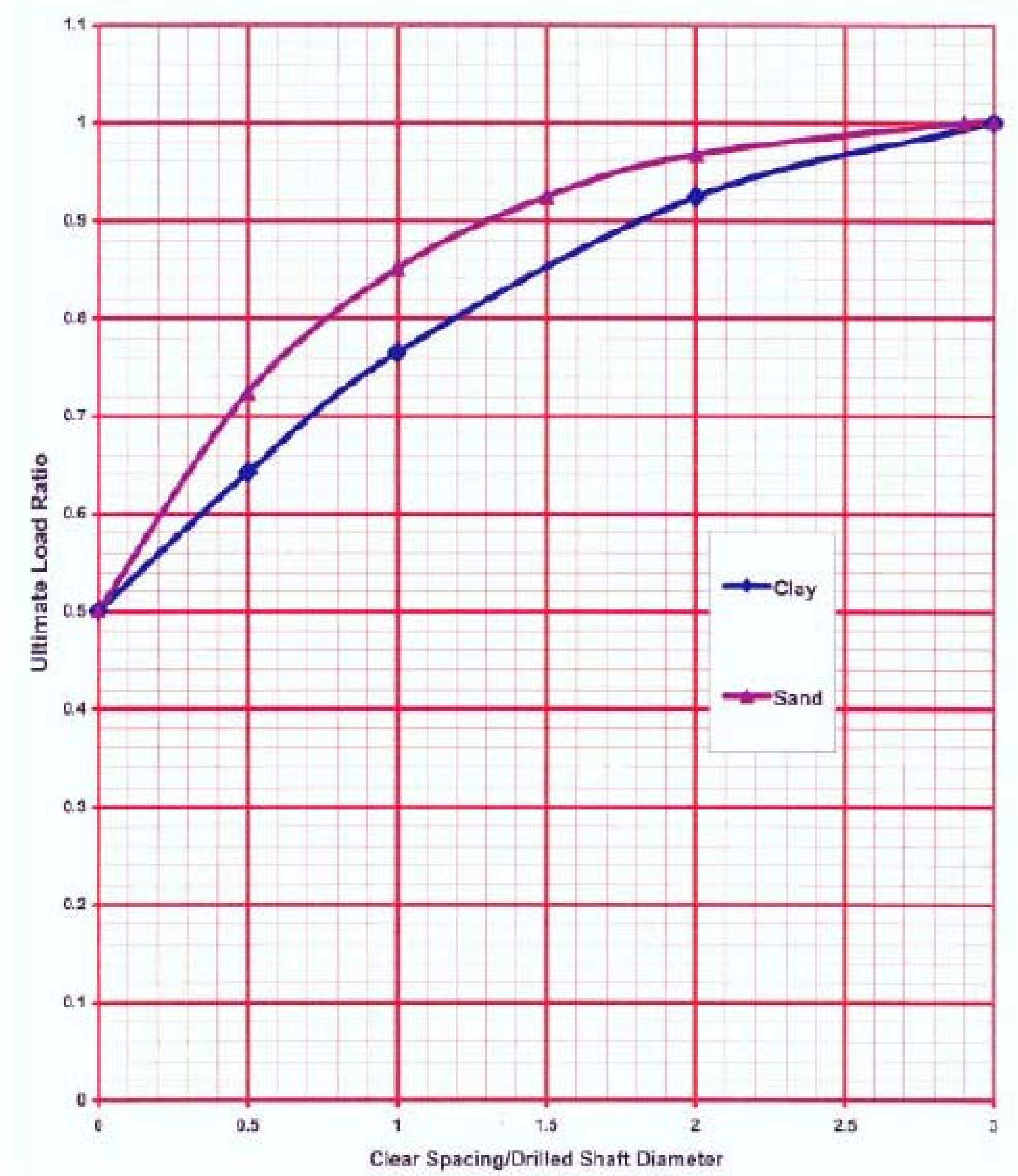


Figure 6-1. Ultimate Load Ratio vs. Clear Spacing/Drilled Shaft Diameter for Various Soil types

Reference:

TXDOT Geotechnical Manual 2012, Page 6-12

Project: Proposed AA Memorial @ Bates Allen Park Fort Bend County, Texas	ASSOCIATED TESTING LABORATORIES	Project Number: G22-201
Client: Fort Bend County Parks & Recreation Dept. Missouri City, Texas	**Pile Group Efficiency**	Figure 4

Appendix A

BORING LOG B-1

PROJECT: AA Memorial At Bates Allen Park, On Charlie Roberts Lane, Fort Bend County, Texas	CLIENT: Fort Bend County Parks & Recreation Department	Project No: **G22-201**

COORDINATES	GROUND WATER		Boring Depth		Start Date/Finish	
ELEVATION	Init 26'	15 min 23.9'	0	40	01/09/23	01/09/23

Elevation (fT)	Depth	SAMPLE	Symbol	Description	Pocket Penetrometer (tsf)	SPT/THD	Natural Moisture (%)	Liquid Limit	Plastic Limit	Plasticity Index	Dry Density (pcf)	UC/UU Compression (tsf)	Failure Strain (%)	% Passing 200	Other Tests
	0			SANDY LEAN CLAY (CL), stiff to hard, medium to high plasticity, dark gray	1.5		22.2	43	20	23				51.3	
				-reddish brown below 2'	2.0		16.0				108	2.00	7.98		
					1.5		15.4								
	5			-with calcareous nodules below 6'	3.5		14.7	31	18	13	115	1.19	3.56	69.0	
				-light gray and tan below 8'	4.5		17.0								
	10			-with ferrous nodules below 12'	4.5		15.7				116	4.78	9.78		
					4.5		15.7	45	13	32				50.7	
					4.5		15.1				117	4.75	7.09		
	15				4.5		14.9				117	5.50	4.58		
					3.5		14.4	31	15	16				50.2	
	20														
				SILTY SAND (SM), very dense, non plastic, reddish browm		50/4"	9.3							20.0	
	25														
						16/40/50	19.9							19.4	
	30														

Note:

Driller: Van & Sons

Logger: Jeremany & Voctor

BORING LOG B-1

ASSOCIATED TESTING LABORATORIES

PROJECT	CLIENT			Project No:	
AA Memorial At Bates Allen Park, On Charlie Roberts Lane, Fort Bend County, Texas	Fort Bend County Parks & Recreation Department			G22-201	
COORDINATES	GROUND WATER		Boring Depth	Start Date/Finish	
ELEVATION	Init 26'	15 min 23.9'	**32.5** / 40	01/09/23	01/09/23

Elevation (fT)	Depth	SAMPLE	Symbol	Description	Pocket Penetrometer (tsf)	SPT/THD	Natural Moisture (%)	Liquid Limit	Plastic Limit	Plasticity Index	Dry Density (pcf)	UC/UU Compression (tsf)	Failure Strain (%)	% Passing 200	Other Tests
	35			CLAYEY SAND (SC), very dense, medium plasticity, reddish brown		17/28/45	21.8	31	18	13				21.1	
	40			SILTY SAND (SM), very dense, non plastic, reddish brown		29/42/48	22.9	17	16	1				42.1	
	45														
	50														
	55														
	60														
	65														

Note:

Driller: Van & Sons

Logger: Jeremany & Voctor

BORING LOG B-2

PROJECT	CLIENT	Project No:
AA Memorial At Bates Allen Park, On Charlie Roberts Lane, Fort Bend County, Texas	Fort Bend County Parks & Recreation Department	G22-201

COORDINATES	GROUND WATER		Boring Depth		Start Date/Finish	
ELEVATION	Init 26'	15 min 24'	0	40	01/09/23	01/09/23

Elevation (fT)	Depth	SAMPLE	Symbol	Description	Pocket Penetrometer (tsf)	SPT/THD	Natural Moisture (%)	Liquid Limit	Plastic Limit	Plasticity Index	Dry Density (pcf)	UC/UU Compression (tsf)	Failure Strain (%)	% Passing 200	Other Tests
	0			SANDY LEAN CLAY (CL), stiff to hard, high plasticity, dark gray	2.0		24.1								
				-reddish brown below 2'	3.5		15.5	43	14	29				64.0	
					2.5		16.4				114	1.33	9.34		
	5			-with calcareous nodules below 6'	4.0		18.3				111	1.94	2.43		
				-light gray and tan below 8'	4.0		18.9	42	16	26	112	2.62	3.857	53.0	
	10			-with ferrous nodules below 12'	4.5		16.7				114	4.50	9.41		
					4.5		15.9	45	14	31				69.9	
					4.5		18.9	44	15	29	111	2.84	7.60	53.8	
	15				4.5		16.8	42	15	27	111	2.59	9.87	52.3	
				-reddish brown below 18'	4.5		17.6	43	15	28					
	20														
				SILTY SAND (SM), very dense,non plastic, reddish brown		50/5"	9.4							21.5	
	25														
						18/45/50	21.2							25.8	
	30														

Note:

Driller: Van & Sons

Logger: Jeremany & Voctor

BORING LOG B-2

ASSOCIATED TESTING LABORATORIES

PROJECT	CLIENT	Project No:
AA Memorial At Bates Allen Park, On Charlie Roberts Lane, Fort Bend County, Texas	Fort Bend County Parks & Recreation Department	G22-201

COORDINATES	GROUND WATER		Boring Depth		Start Date/Finish	
ELEVATION	Init: 26'	15 min: 24'	**32.5**	40	01/09/23	01/09/23

Elevation (fT)	Depth	SAMPLE	Symbol	Description	Pocket Penetrometer (tsf)	SPT/THD	Natural Moisture (%)	Liquid Limit	Plastic Limit	Plasticity Index	Dry Density (pcf)	UC/UU Compression (tsf)	Failure Strain (%)	% Passing 200	Other Tests
				SANDY LEAN CLAY (CL), hard, medium plasticity ,reddish brown		15/26/40	13.8	30	16	14				68.1	
	35														
						19/39/45	20.4	24	13	11				51.5	
	40														
	45														
	50														
	55														
	60														
	65														

Note:

Driller: Van & Sons

Logger: Jeremany & Voctor

BORING LOG B-3

ASSOCIATED TESTING LABORATORIES

PROJECT	CLIENT	
AA Memorial At Bates Allen Park, On Charlie Roberts Lane, Fort Bend County, Texas	Fort Bend County Parks & Recreation Department	Project No: **G22-201**

COORDINATES	GROUND WATER		Boring Depth		Start Date/Finish	
ELEVATION	Init	15 min	0	20	01/05/23	01/05/23

Elevation (fT)	Depth	SAMPLE	Symbol	Description	Pocket Penetrometer (tsf)	SPT/THD	Natural Moisture (%)	Liquid Limit	Plastic Limit	Plasticity Index	Dry Density (pcf)	UC/UU Compression (tsf)	Failure Strain (%)	% Passing 200	Other Tests
	0			SANDY LEAN CLAY (CL), stiff to very stiff, medium to high plasticity, light gray and tan	3.0		21.2								
					3.5		13.1	46	15	31	116	1.03	14.13	50.9	
	5			-reddish brown with ferrous nodules below 4'	4.0		18.7								
				-with calcareous nodules below 6'	4.5		15.9								
					4.5		13.2	42	18	24	109	3.23	4.32	79.5	
	10				4.5		17.5								
					4.5		8.5	26	15	11	121	2.95	4.91	52.9	
	15			SILTY SAND (SM), dense, non plastic, reddish brown		13/15/17	10.7							44.5	
						12/16/19	9.2								
						13/17/20	7.3								
	20														
	25														
	30														

Note:

Driller: ACE GeoDrilling

Logger: Xavier & Adrian

BORING LOG B-4

PROJECT	CLIENT	Project No:
AA Memorial At Bates Allen Park, On Charlie Roberts Lane, Fort Bend County, Texas	Fort Bend County Parks & Recreation Department	G22-201

COORDINATES	GROUND WATER		Boring Depth		Start Date/Finish	
ELEVATION	Init	15 min	0	20	01/05/23	01/05/23

Elevation (fT)	Depth	SAMPLE	Symbol	Description	Pocket Penetrometer (tsf)	SPT/THD	Natural Moisture (%)	Liquid Limit	Plastic Limit	Plasticity Index	Dry Density (pcf)	UC/UU Compression (tsf)	Failure Strain (%)	% Passing 200	Other Tests
	0			SANNDY FAT CLAY (CH), very stiff, high plasticity, light gray and tan	2.5		28.3	63	23	40				52.1	
				-with calcareous and ferrous nodules below 2'	3.0		27.5								
	5			LEAN CLAY WITH SAND (CL), very stiff to hard, high plasticity, tan and light gray	3.0		15.7				113	4.93	14.16		
				-with calcareous nodules below 6'	4.5		11.5	39	15	24	114	6.53	6.721	70.8	
				-reddish brown with ferrous nodules below 8'	4.5		12.6								
	10				4.5		15.8	43	15	28	107	3.47	4.404	84.7	
				SILTY SAND (SM), medium dense, non plastic, reddish brown		10/13/16	8.6							48.1	
	15			-dense below 16'		13/15/19	10.7								
						14/17/20	9.2							48.8	
						13/18/21	6.9								
	20														
	25														
	30														

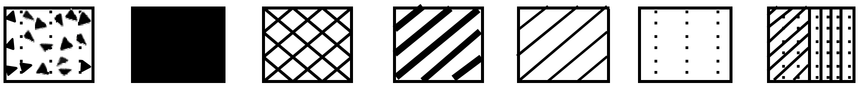
Note:

Driller: ACE GeoDrilling

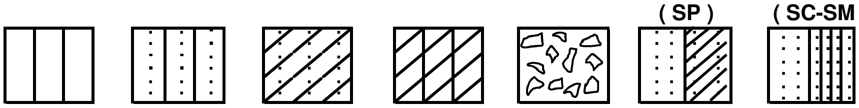
Logger: Xavier & Adrian

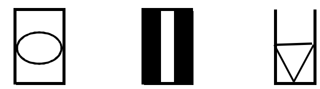
KEY TO LOG TERMS AND SYMBOLS

SOIL TYPE / SAMPLER TYPE



CONCRETE	ASPHALT	FILL	FAT CLAY (CH)	LEAN CLAY (CL)	Poorly Graded Sand (SP)	Silty Clayey Sand (SC-SM)	AUGER SAMPLE	SHELBY TUBE	SPLIT SPOON





SILT (ML)	SILTY SAND (SM)	CLAYEY SAND (SC)	SILTY CLAY (CL-ML)	GRAVEL	Poorly Graded Sand with Clay (SP-SC)	Poorly Graded Sand with Silt (SP-SM)	NO RECOVERY	ROCK CORE	TCP / THD Value

UNIFIED SOIL CLASSIFICATION SYSTEM - ASTM D 2487

MAJOR DIVISIONS			LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS LESS THAN 50% PASSING No. 200 SIEVE	GRAVEL & GRAVELY SOILS LESS THAN 50% PASSING No.4 SIEVE	CLEAN GRAVELS LITTLE OR NO FINES	GW	WELL GRADEED GRAVELS,GRAVELSAND MIXTURES WITH LITTLE OR NO FINES
			GP	POORLY GRADED GRAVELS,GRAVEL SAND MIXTURES WITH LITTLE OR NO FINES
		W/ APPRECIATEBLE FINES	GM	SILTY GRAVELS,GRAVEL SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS,GRAVEL SAND-CLAY MIXTURES
	SANDS MORE THAN 50% PASSING No.4 SIEVE	CLEAN SANDS LITTLE FINES	SW	WELL GRADED SAND,GRAVELY SAND (LITTLE FINES)
			SP	POORLY GRADED SANDS,GRAVELY SAND(L. FINES)
		SANDS WITH APPREA. FINES	SM	SILTY SANDS,SAND-SILT MIXTURES
			SC	CLAYEY SANDS,SAND-CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS & VERY FINE SANDS,ROCK FLOUR SILTY OR CLAYEY FINE SANDS OR CLAYEY SILT W/PI
			CL	INORGANIC CLAY OF LOW TO MEDIUM PI LEAN CLAY, GRAVELY LEAN CLAYS,SANDY LEAN CLAYS,LEAN CLAYS WITH SAND
			OL	ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PI
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS,MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY FAT CLAYS, FAT CLAYS WITH SAND, SANDY FAT CLAYS, FAT CLAYS WITH GRAVEL
			OH	ORGANIC CLAYS OF MED TO HIGH PI, ORGANIC SILT
HIGHLY ORGANIC SOIL			FT	PEAT AND OTHER HIGHLY ORGANIC SOILS
UNCLASSIFIED FILL MATERIALS			ARTIFICIALLY DEPOSITED AND OTHER UNCLASSIFIED SOILS FILL MATERIALS	

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNDRAINED SHEAR STRENGTH IN TSF	SPT N-VALUE
VERY SOFT	< 0.125	< 2
SOFT	0.125 TO 0.25	2 TO 4
FIRM	0.25 TO 0.5	4 TO 8
STIFF	0.5 TO 1.0	8 TO 16
VERY STIFF	1.0 TO 2.0	16 TO 32
HARD	> 2.0	> 32

RELATIVE DENSITY - GRANULAR SOILS

CONSISTENCY	SPT N-VALUE (BLOWS PER FT)
VERY LOOSE	< 4
LOOSE	5 - 10
MEDIUM DENSE	11 - 30
DENSE	31 - 50
VERY DENSE	> 50

Density (Cohesionless)	Consistency (Cohesive)	TCP-VALUES (BLOWS PER FT)
VERY LOOSE	VERY SOFT	0-8
LOOSE	SOFT	8-20
SLIGHTLY COMPACT	STIFF	20-40
COMPACT	VERY STIFF	40-80
DENSE	HARD	80-5"/100
VERY DENSE	VERY HARD	5"/100 - 0"/100

Note. U.S.S denotes undrained shear strength

DEGREE OF PLASTICITY OF COHESIVE SOILS

PLASTICITY INDEX	0-4	5 - 10	11 - 20	21 - 40	> 40
PLASTICITY CLASSIFICATION	NONE	SLIGHT	MEDIUM	HIGH	VERY HIGH

CLASSIFICATION OF GRANULAR SOILS

U.S.STANDARD SIEVE SIZE(S)

6" 3" 3/4" 4 10 40 200

BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY	CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE		

152 76.2 19.1 4.76 2.0 0.420 0.074 0.002

GRAIN SIZE IN MM

Appendix B

EXPANSIVE SOILS

The high plasticity clays at this site may experience volume changes with changes in moisture content. During hot, dry periods the soil loses moisture and shrinks. Conversely, during extended wet weather cycles, the soil gains moisture and swells. This seasonal movement can exert considerable stresses on structures supported by these soils.

Under normal conditions, water evaporates from the surface of the soil and it replaced by water drawn upward by capillary action from below. When a floor slab and vapor barrier are placed on the surface, this evaporation is mitigated. Moisture continues to be drawn upward until a balanced condition is developed. During wet season, the soils near the edge of the slab receive more moisture than the soils at the center of the slab. During dry season, the soils near the edge of the slab dries out more than the soils at the center of the slab. These conditions may cause differential movement and cracking of the slab.

Several preventive measures are available to reduce the effects of volume changes in these soils. One is to use deep grade beams to provide a barrier to evaporation of water from below the slab. Another is to place a paved strip around the perimeter of the building. This strip acts as a buffer zone, with most of the differential movement taking place in this area. A minimum width of 5 feet is normally recommended. Residences or other structures may use a mulch bed around the perimeter to help keep moisture from evaporating. Lime stabilization of a 5 foot wide strip outside the building line will also help prevent moisture loss.

Trees can also contribute to the soil shrink/swell movement in highly plastic soils. During extended periods of dry weather, trees remove water from the soil and cause shrinkage. This shrinkage causes movement of the soils downward and toward the tree and can seriously damage nearby structures. This condition can normally be neutralized by removing the trees or by placing the structure on foundations bearing below the affected soil. Existing trees absorb water from the soil through the roots. This leads to the formation of isolated pockets of dry soils near the tree roots. When the trees are removed and the building constructed on top of it, the isolated pockets of dry soil when exposed to moisture will swell more than the surrounding soils. This will lead to differential swelling. Although, the tree roots are generally found in the top few feet, there may be cases where tree roots may be present at deeper depths. In this event, the foundation is designed based on the potential vertical rise (PVR) of deeper soils, permeability of soils and probability of moisture changes in soils at deeper depths.

SECTION 03 49 10 - GLASS FIBER REINFORCED CONCRETE

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Requirements for glass fiber reinforced concrete (GFRC) panels, consisting of GFRC, panel frames, anchors, and connection hardware.

1.02 REFERENCE STANDARDS

A. ASTM A27/A27M - Standard Specification for Steel Castings, Carbon, for General Application; 2020.

B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.

C. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).

D. ASTM A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished; 2018.

E. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.

F. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

G. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; 2021.

H. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2023.

I. ASTM A513/A513M - Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing; 2020a.

J. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.

K. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings; 2020.

L. ASTM A1003/A1003M - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members; 2015.

M. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2023, with Editorial Revision.

N. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2023.

O. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.

P. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2023.

Q. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar; 2018.

R. ASTM C150/C150M - Standard Specification for Portland Cement; 2022.

S. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete; 2019, with Editorial Revision (2022).

T. ASTM C979/C979M - Standard Specification for Pigments for Integrally Colored Concrete; 2016.

U. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2023).

V. AWS D1.3/D1.3M - Structural Welding Code - Sheet Steel; 2018, with Errata (2022).

W. PCI MNL-128 - Recommended Practice for Glass Fiber Reinforced Concrete Panels; 2001.

X. PCI MNL-130 - Quality Control for Plants and Production of Glass Fiber Reinforced Concrete Products; 2009.

Y. SSPC-SP 2 - Hand Tool Cleaning; 2018.

Z. SSPC-SP 6/NACE No.3 - Commercial Blast Cleaning; 2006.

1.03 DEFINITIONS

A. Design Reference Sample: Sample of approved GFRC color, finish and texture, preapproved by Architect.

1.04 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide GFRC panels, including panel frames, anchors, and connections, capable of withstanding the following design loads, as well as the effects of thermal- and moisture induced volume changes, according to load factors and combinations established in PCI MNL-128, "Recommended Practice for Glass Fiber Reinforced Concrete Panel."
   1. Deflection: Design panel frames to withstand design loads without lateral deflections greater than 1/240 of wall span.
   2. Thermal Movements: Provide for thermal movements resulting from annual ambient temperature changes of 100 Degrees.
   3. Design panel frames and connections to accommodate deflections and other building movements.
   4. Design panel frames to transfer window loads to building structure.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene one week before starting work of this section.

1.06 SUBMITTALS

A. Product Data: For each type of product indicated. Include GFRC design mixes.

B. Shop Drawings: Show fabrication and installation details for GFRC panels, including the following:
   1. Structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   2. Panel elevations, sections, and dimensions.
   3. Thickness of facing mix, GFRC backing, and bonding pads for typical panels.
   4. Finishes.
   5. Joint and connection details.
   6. Erection details.
   7. Panel frame details for typical panels, including sizes, spacings, thicknesses, and yield strengths of various members.
   8. Locations and details of connection hardware attached to structure.
   9. Size, location, and details of flex, gravity, and seismic anchors for typical panels.
   10. Other items sprayed into panels.
   11. Erection sequence for special conditions.
   12. Relationship to adjacent materials.
   13. Descriptions of loose, cast-in, and field hardware.
       a. Samples: Representative of finished exposed face of GFRC showing the full range of colors and textures expected, 10 x 10 inches and of actual thickness.

C. Welding certificates.
   1. Steel Sheet Certification. For steel sheet used in cold-formed steel panel framing.
   2. Mill Certificates: For structural-steel shapes and hollow structural sections used in panel framing.
   3. Qualification Data: For GFRC manufacturer, including proof of current PCI Plant Certification.

4. Source Quality-Control Program: For GFRC manufacturer.
5. Source Quality-Control Test Reports: For GFRC, inserts, and anchors.

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer who participates in PCI's Plant Certification Program and is designated a PCI-Certified Plant for Group G, Glass Fiber Reinforced Concrete.

B. Manufacturer's responsibility includes fabricating GFRC panels and providing professional engineering services needed to assume engineering responsibility for GFRC panels.

C. Engineering responsibility includes preparation of Shop Drawings and comprehensive engineering analysis, based on GFRC production test values, by a qualified professional engineer experienced in GFRC design.
   1. Provide signed and sealed engineering drawings for GFRC cladding panels, including:
      a. Panel dimensions, thickness, and reinforcement details.
      b. Attachment methods and spacing for panel installation.
      c. Joint detailing and sealant requirements.
   2. Provide signed and sealed engineering drawings for steel framing, including:
      a. Member sizes, configurations, and connection details.
      b. Load calculations and structural analysis.
      c. Erection details and anchor bolt locations.

D. Steel Sheet Certifications: Obtain mill certificates, signed by manufacturers of steel sheet or test reports from a qualified testing agency indicating steel sheet used in cold-formed metal panel framing complies with requirements, including uncoated steel thickness, yield strength, tensile strength, total elongation, chemical requirements, and galvanized-coating thickness.

E. Mill Certificates: Obtain certified mill test report from manufacturer of structural-steel shapes and hollow structural sections used in panel framing indicating compliance of these products with requirements.

F. Source Limitations: Obtain GFRC panels through one source from a single manufacturer.

G. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code-Steel," and AWS D1.3/D1.3M, "Structural Welding Code--Sheet Steel."

H. PCI Manuals: Comply with requirements and recommendations in the following PCI manuals, unless more stringent requirements are indicated:

I. PCI MNL-128, "Recommended Practice for Glass Fiber Reinforced Concrete Panels."

J. PCI MNL-130, "Manual for Quality Control for Plants and Production of Glass Fiber Reinforced Concrete Products."

K. Comply with AISI's "Specification for the Design of Cold-Formed Steel Structural Members."

L. Conduct conference at Project site.

1.08 MOCK-UP

A. Construct one panel as directed by Architect with surface finish applied, including supporting backup structure, attachments, fire, air and vaport seals applied.

B. Located where directed.

1.09 PROJECT CONDITIONS

A. Coordinate the Work with installation of backup supporting structure.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Handle and transport GFRC panels to avoid damage.
   1. Place non staining resilient spacers between panels.
   2. Support panels during shipment on non-staining material.
   3. Protect panels from dirt and damage during handling and transport.

B. Store GFRC panels to protect from contact with soil, staining, and physical damage.
   1. Store panels with non-staining resilient supports in same positions as when transported.
   2. Store panels on firm, level, and smooth surfaces.
   3. Place stored panels so identification marks are clearly visible.

PART 2 - PRODUCTS

2.01 MOLD MATERIALS

A. Molds: Rigid, dimensionally stable, non-absorptive material, warp and buckle free, that will provide continuous and true GFRC surfaces; nonreactive with GFRC and capable of producing required finish surfaces.
   1. Mold-Release Agent: Commercially produced liquid-release agent that will not bond with, stain, or adversely affect GFRC surfaces and will not impair subsequent surface or joint treatments of GFRC.

2.02 GFRC MATERIALS

A. Portland Cement: ASTM C150/C150M Type I, II, or III.
   1. For surfaces exposed to view in finished structure, use white of same type, brand, and source throughout GFRC production.

B. Glass Fibers: Alkali resistant, with a minimum zirconia content of 16 percent, 1 1/2” long, specifically produced for use in GFRC, and complying with PCI MNL 130.

C. Sand: Washed and dried silica, complying with composition requirements of ASTM C144; passing No. 20 (0.85-mm) sieve with a maximum of 2 percent passing No. 100 (0.15-mm) sieve.

D. Facing Aggregate: ASTM C33/C33M, except for gradation, and PCI MNL 130, 1/4-inch (6-mm) maximum size.
   1. Aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining; to match sample.

E. Coloring Admixture: ASTM C979/C979M, synthetic mineral-oxide pigments or colored water-reducing admixtures, temperature stable, nonfading, and alkali resistant.

F. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of GFRC and complying with chemical limits of PCI MNL-130.

G. Polymer Curing Admixture: Acrylic thermoplastic copolymer dispersion complying with PCI MNL-130.

H. Chemical Admixtures: ASTM C494/C494M, containing not more than 0.1 percent chloride ions.

2.03 ANCHORS, CONNECTORS, AND MISCELLANEOUS MATERIALS

A. Carbon-Steel Shapes and Plates: ASTM A36/A36M. Finish steel shapes and plates less than 3/16 inch (4.76 mm) thick as follows:
   1. Finish: Zinc coated by hot-dip process according to ASTM A123/A123M , after fabrication, or ASTM A153/A153M, as applicable electro deposition according to ASTM B633 A, SC3.
   2. Finish: Shop primed on surfaces prepared to comply with SSPC-SP 2, "Hand Tool Cleaning,"

B. Carbon-Steel Bars: ASTM A108, AISI Grade 1018. Finish steel bars less than 3/16 inch (4.76 mm) thick as follows:
   1. Finish: Zinc coated by hot-dip process according to ASTM A123/A123M , after fabrication, or ASTM A153/A153M, as applicable electro deposition according to ASTM B633, SC3.
   2. Finish: Shop primed with MPI 79 or SSPC-Paint 25 on surfaces prepared to comply with SSPC-SP 2, "Hand Tool Cleaning," or better.

C. Malleable-Iron Castings: ASTM A47/A47M , Grade 32510 (Grade 22010).

D. Carbon-Steel Castings: ASTM A27/A27M, Grade 60-30 (Grade 415-205).

E. Bolts: ASTM A307 or ASTM A325 (ASTM F568M or ASTMA325M).

F. Reglets: PVC extrusions or FRY C.O. Reglet.

2.04 PANEL FRAME MATERIALS

A. Cold-Formed Steel Framing: Manufacturer's standard C-shaped steel studs, complying with AISI's "Specification for the Design of Cold-Formed Steel Structural Members," minimum uncoated steel thickness of 0.0538 inch (1.37 mm)], with stiffened flanges, U-shaped steel track, and of the following steel sheet:
   1. Metallic-Coated Steel Sheet: ASTM A653/A653M, structural-steel sheet, G60 zinc coating, of grade required by structural performance of framing.
   2. Painted, Nonmetallic-Coated Steel Sheet: ASTM A1011/A1011M hot rolled or ASTM ASTM A1008/A1008M cold rolled; nonmetallic coated according to ASTM A1003/A1003M; of grade required by structural performance of framing.

B. Hollow Structural Sections: Steel tubing, ASTM A500/A500M, Grade B, or ASTM A513/A513M. Finish hollow structural sections with wall thickness less than 3/16 inch (4.76 mm) as follows:
   1. Finish: Shop Primer with organic zinc-rich primer complying with SSPC-paint 20 on surfaces prepared to comply with SSPC-SP 6/NACE No.3, “Commercial Blast Cleaning,”
   2. Finish: Zinc coated by hot-dip process according to ASTM A123/A123M, after fabrication, or ASTM A153/A153M, as applicable.
   3. Primer: SSPC-Paint 25 on surfaces prepared to comply with SSPC-SP 2, Hand Tool Cleaning," or better.

C. Steel Channels and Angles: ASTM A36/A36M , finished as follows:
   1. Primer: MPI 79 or SSPC-Paint 25 on surfaces prepared to comply with SSPC-SP 2, "Hand Tool Cleaning," or better.

2.05 GFRC MIXES

A. Backing Mix: Proportion backing mix of portland cement, glass fibers, sand, and admixtures to comply with design requirements. Provide nominal glass-fiber content of not less than 5 percent by weight of total mix.

B. Face Mix: Proportion face mix of portland cement, fine and coarse aggregates, and admixtures to comply with design requirements.

C. Mist Coat Mix: Portland cement, sand slurry, and admixtures, of same proportions as backing mix without glass fibers.

D. Polymer Curing Admixture: 6 to 7 percent by weight of polymer curing admixture solids to dry portland cement.

E. Coloring Admixture: Not to exceed 5 percent of cement weight.

2.06 PANEL FRAME FABRICATION

A. Fabricate panel frames and accessories plumb, square, true to line, and with components securely fastened, according to Shop Drawings and in accordance with Delegated Design.
   1. Fabricate panel frames using jigs or templates.
   2. Cut cold-formed metal framing members by sawing or shearing; do not torch cut.
   3. Fasten cold-formed metal framing members by welding. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
   4. Fasten framing members of hollow structural sections, steel channels, or steel angles by welding. Comply with AWS D1.1/D1.1M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
   5. Weld flex, gravity, and seismic anchors to panel frames.

B. Reinforce, stiffen, and brace framing assemblies, if necessary, to withstand handling, delivery, and erection stresses. Lift fabricated assemblies in a manner that prevents damage or significant distortion.

C. Galvanizing Repair: Touch up accessible damaged galvanized surfaces according to ASTM A780/A780M.

D. Painting Repair: Touch up accessible damaged painted surfaces using same primer.

2.07 MOLD FABRICATION

A. Construct molds that will result in finished GFRC complying with profiles, dimensions, and tolerances indicated, without damaging GFRC during stripping. Construct molds to prevent water leakage and loss of cement paste.
   1. Coat contact surfaces of molds with form-release agent.

B. Locate, place and secure flashing reglets accurately.

2.08 GFRC FABRICATION

A. Proportioning and Mixing: For backing mix, meter sand/cement slurry and glass fibers to spray head at rates to achieve design mix proportions and glass-fiber content according to PCI MNL-130 procedures.

B. Spray Application: Comply with general procedures as follows:
   1. Spray mist coat over molds to a nominal thickness of 1/8 inch (3 mm) on planar surfaces.
   2. Spray or place face mix in thickness indicated on Shop Drawings.
   3. Proceed with spraying backing mix before [mist coat] [face mix] has set, using procedures that produce a uniform thickness and even distribution of glass fibers and matrix.
   4. Consolidate backing mix by rolling or other technique to achieve complete encapsulation of glass fibers and compaction.
   5. Measure thickness with a pin gage or other acceptable method at least once for each 5 sq. ft. (0.5 sq.m) of panel surface. Take not less than six measurements per panel.

C. Hand form and consolidate intricate details, incorporate formers or infill materials, and over spray before material reaches initial set to ensure complete bonding.

D. Attach panel frame to GFRC before initial set of GFRC backing, maintaining a minimum clearance of 1/2 inch (13 mm) from GFRC backing, and without anchors protruding into GFRC backing.

E. Build up homogeneous GFRC bonding pads over anchor feet, maintaining a minimum thickness of 1/2 inch (13 mm) over top of anchor foot, before initial set of GFRC backing.

F. Inserts and Embedments: Build up homogeneous GFRC bosses or bonding pads over inserts and embedments to provide sufficient anchorage and embedment to comply with design requirements.

G. Curing: Employ initial curing method that will ensure sufficient strength for removing units from mold.
   1. After initial curing, remove panel from mold and place in a controlled curing environment.
   2. Keep GFRC panels continuously moist for a minimum of seven days, unless polymer curing admixture was used. Maintain temperature between 60 and 120 degF (16 and 49 degC) during this period.

H. Panel Identification: Mark each GFRC panel to correspond with identification mark on Shop Drawings. Mark each panel with its casting date.

2.09 FABRICATION TOLERANCES

A. Manufacturing Tolerances: Manufacture GFRC panels so each finished unit complies with PCI MNL-130 for dimension, position, and tolerances.

B. Manufacturing Tolerances: Manufacture GFRC panels so each finished unit complies with the following dimensional tolerances. For dimensional tolerances not listed below, comply with PCI MNL-130.
   1. Overall, Height and Width of Units, measured at the Face Adjacent to Mold: As follows:
      a. 10 feet (3 m) or under, plus or minus 1/8 inch (3 mm).
      b. More than 10 feet (3 m), plus or minus 1/8 inch per 10 feet (3 mm per 3 m); 1/4 inch (6 mm) maximum.
   2. Edge Return Thickness: Plus 1/2 inch (13 mm), minus 0 inch (0 mm).

3. Architectural Facing Thickness: Plus 1/8 inch (3 mm), minus 0 inch (0 mm).
4. Backing Thickness: Plus 1/4 inch (6 mm), minus 0 inch (0 mm).
5. Panel Depth from Face of Skin to Back of Panel Frame or Integral Rib: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
6. Angular Variation of Plane of Side Mold: Plus or minus 1/32 inch per 3 inches (0.8 mm per 75 mm) of depth or plus or minus 1/16 inch (1.5 mm) total, whichever is greater.
7. Variation from Square or Designated Skew (Difference in Length of Two Diagonal Measurements): Plus or minus 1/8 inch per 72 inches (3 mm per 1800 mm) or plus or minus 1/4 inch (6 mm) total, whichever is greater.
8. Local Smoothness: 1/4 inch per 10 feet (6 mm per 3 m).
9. Bowing: Not to exceed L/240 unless unit meets erection tolerances using connection adjustments.
10. Length and Width of Blockouts and Openings within One Unit: Plus or minus 1/4 inch (6 mm).
11. Location of Window Openings within Panels: Plus or minus 1/4 inch (6 mm).
12. 12.Maximum Permissible Warpage of One Corner out of the Plane of the Other Three: 1/16 inch per 12 inches (1.5 mm per 300 mm) of distance from nearest adjacent corner.

C. Position Tolerances: Measured from datum line locations, as indicated on Shop Drawings.
1. Panel Frame and Track: Plus or minus 1/4 inch (6 mm).
2. Flashing Reglets at Edge of Panel: Plus or minus 1/4 inch (6 mm).
3. Inserts: Plus or minus 1/2 inch (13 mm).
4. Special Handling Devices: Plus or minus 3 inches (75 mm).
5. Location of Bearing Devices: Plus or minus 1/4 inch (6 mm).
6. Blockouts: Plus or minus 3/8 inch (10 mm).

D. Panel Frame Tolerances: As follows:
1. Vertical and Horizontal Alignment: 1/4 inch per 10 feet (6 mm per 3 m).
2. Spacing of Framing Member: Plus or minus 3/8 inch (10 mm).
3. Squareness of Frame: Difference in length of diagonals of 3/8 inch (10 mm).
4. Overall Size of Frame: Plus or minus 3/8 inch (10 mm).

2.10 FINISHES

A. Finish exposed-face surfaces of GFRC as follows to match approved sample. Panel faces shall be free of joint marks, grain, or other obvious defects.
1. Sand- or Abrasive-Blast Finish: Use abrasive grit, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces.

2.11 SOURCE QUALITY CONTROL

A. Quality-Control Testing: Establish and maintain a quality-control program for manufacturing GFRC panels according to PCI MNL-130.
1. Test materials and inspect production techniques.
2. Quality-control program shall monitor glass fiber content, spray rate, unit weight, product physical properties, anchor pull-off and shear strength, and curing period and conditions.
3. Prepare test specimens and test according to ASTM C1228, PCI MNL-128, and PCI MNL-130 procedures.
4. Produce test boards at a rate not less than one per work shift machine and for each mix design.
a. For each test board, determine glass fiber content according to ASTM C1229, and flexural yield and ultimate strength according to ASTM C947.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine structure and conditions for compliance with requirements for installation tolerances, true and level bearing surfaces, and other conditions affecting performance.
1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Installation shall be performed by qualified personnel experienced in GFRC panel and steel framing installation.

B. GFRC panels shall be installed in accordancie with approved shop drawings, ensuring proper alignment, spacing and joint detailing.

C. Steel framing shall be erected and anchored securely to building structure per approved engineering drawings.

D. Install clips, hangers, and other accessories required for connecting GFRC panels to supporting members and backup materials.

E. Lift GFRC panels and install without damage.

F. Install GFRC panels level, plumb, square, and in alignment. Provide temporary supports and bracing as required to maintain position, stability, and alignment of panels until permanent connections are completed.
   1. Maintain horizontal and vertical joint alignment and uniform joint width.
   2. Remove projecting hoisting devices.

G. Connect GFRC panels in position by bolting or welding, or both, as indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as possible after connecting is completed.

H. Welding: Comply with applicable AWS D1.1 and AWS D1.3 requirements for welding, appearance, quality of welds, and methods used in correcting welding work.
   1. Protect GFRC panels from damage by field welding or cutting operations, and provide noncombustible shields as required.

I. At bolted connections, use lock washers or other acceptable means to prevent loosening of nuts.

3.03 ERECTION TOLERANCES

A. Erect GFRC panels to comply with the following noncumulative tolerances:
   1. Plan Location from Building Grid Datum: Plus or minus 1/2 inch (13 mm).
   2. Top Elevation from Nominal Top Elevation: As follows:
      a. Exposed Individual Panel: Plus or minus 1/4 inch (6 mm).
      b. Non-exposed Individual Panel: Plus or minus 1/2 inch (13 mm).
      c. Exposed Panel relative to Adjacent Panel: 1/4 inch (6 mm).
      d. Non-exposed Panel relative to Adjacent Panel: 1/2 inch (13 mm).
   3. Support Elevation from Nominal Elevation: As follows:
      a. Maximum Low: 1/2 inch (13 mm).
      b. Maximum High: 1/4 inch (6 mm).
   4. Maximum Plumb Variation over the Lesser of Height of Structure or 100 Feet (30 m): 1 inch (25 mm).
   5. Plumb in Any 10 Feet (3 m) of Element Height: 1/4 inch (6 mm).
   6. Maximum Jog in Alignment of Matching Edges: 1/4 inch (6 mm).
   7. Maximum Jog in Alignment of Matching Faces: 1/4 inch (6 mm).
   8. Face Width of Joint: As follows (governs over joint taper):
      a. Panel Dimension 20 Feet (6 m) or Less: Plus or minus 1/4 inch (6 mm).
      b. Panel Dimension More Than 20 Feet (6 m): Plus or minus 5/16 inch (8 mm).
   9. Maximum Joint Taper: 3/8 inch (10 mm).
   10. Joint Taper in 10 Feet (3 m): 1/4 inch (6 mm).
   11. Differential Bowing, as Erected, between Adjacent Members of Same Design: 1/4 inch (6 mm).

3.04 TESTING AND VERIFICATION

A. Conduct performance testing as required to verify compliance with specified requirements, including structural integrity, weather resistance, and fire resistance.

B. Perform visual inspections and non-destructive testing to assess panel and framing integrity.

C. Address any deficiencies indentified during testing and verification processes promptly to ensure project quality and compliance.

3.05 REPAIRS

A. Repairs will be permitted provided structural adequacy of GFRC panel and appearance are not impaired, as approved by Architect.

B. Mix patching materials and repair GFRC so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces.

C. Prepare and repair accessible damaged galvanized coatings with galvanizing repair paint according to ASTM A780/A780M.

D. Remove and replace damaged GFRC panels when repairs do not comply with requirements.

3.06 CLEANING AND PROTECTION

A. Perform cleaning procedures, if necessary, according to GFRC manufacturer's written instructions.

1. Clean soiled GFRC surfaces with detergent and water, using soft fiber brushes and sponges, and rinse with clean water.
2. Prevent damage to GFRC surfaces and staining of adjacent materials.

END OF SECTION