MORRIS-SHEA BRIDGE CO.,INC.
BIRMINGHAM, ALABAMA

Suwannee American Cement Plant, Florida

CFA Piles • Drilled Shafts • Design-Build • Load Test

DEEP FOUNDATIONS CONTRACTORS SINCE 1969

CONSTRUCTION PERIOD:
TBD

OWNER:
Krupp Polysius Corporation

CLIENT:
Krupp Polysius Corporation

STRUCTURAL ENGINEER:
TDB

GEOTECHNICAL ENGINEER:
TBD

SCOPE OF WORK:

1-meter diameter CFA piles: 398

16” diameter CFA piles: 405

Drilled Shafts: #?

3 static and 4 Statnamic tests on 1-meter diameter CFA piles

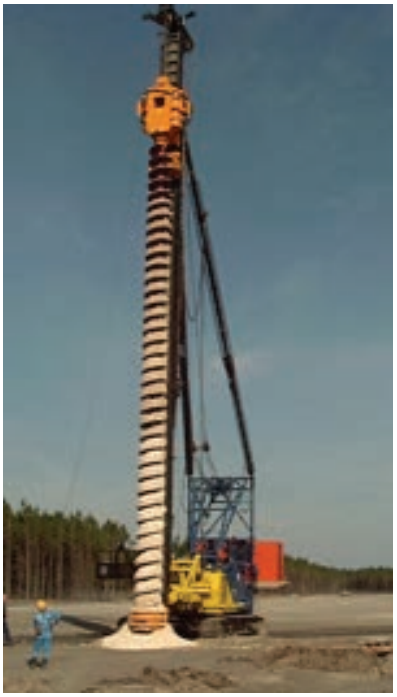
4 static tests on 16” diameter CFA piles

Summary Design-Build Benefits:

The success of design-build foundations depends on experience, vision, and the ability to match the systems to the subsurface soils. Morris-Shea has proven our abilities on numerous industrial facilities, power plants, commercial developments, hotels, casinos, and highway bridge structures.

At the SAC site, the owner met all foundation settlement criteria while realizing a cost saving of approximately $2.25 million, and a schedule saving of 3 months over the base bid option.

Summary:



The construction of the Suwannee American Cement Plant, in Branford, Florida required foundations to meet extremely tight total and differential settlement criteria. High dead, live and dynamic loads were combined with a highly variable subsurface geology to create a challenging design scenario.

Morris-Shea Bridge Company proposed and installed a design build foundation option that met all specification criteria, while providing cost savings in excess of $2.25 million, and a schedule saving of 3 months over the initial foundation option.

Introductions:

The Suwannee American Cement (SAC) Plant includes several highly loaded structures, including mills, pre-heaters, kilns and a number of silos with diameters of 45 to 75 feet, heights of up to 235 feet, and loads of 45,000 to 65,000 kips. In addition, a number of “moderately” loaded structures occur, such as finish mills, precipitator buildings, bag houses and storage bin structures. Settlement criteria specified by Krupp Polysius Corporation were exacting.

The SAC plant is located in Branford, Florida, approximately 40 miles northeast of Gainesville. This area of Florida is known for it's limestone mines, and typically has a variable upper limestone in terms of surface elevation, competency of the limestone, and the presence of relic sinkhole features within the limestone.

To evaluate the proposed site conditions and formulate recommendations for structure foundations, a geotechnical study was commissioned by the owner. Approximately 100 soil borings were ultimately performed for this study, which disclosed sand and clay marine sediments overlying Ocala limestone. The surface of the limestone was highly irregular, varying between 10 and 85 feet below grade.

The upper limestone is typically weak to moderately well cemented, with zones that grade hard. Several solution features are evident in the upper limestone. At depths of 90 to 100 feet the limestone generally becomes more competent.

The foundation recommendations provided in the geotechnical report were divided into two groups. "Moderately loaded structures" were to be supported on either "vibro replacement stone columns" or drilled shafts. Stone columns were to be installed at 5 foot centers and to be taken to the top of limestone or a maximum depth of 75 feet where limestone was not encountered. Drilled shafts were to be drilled to a minimum depth of 90 feet, with a 10 foot socket into "hard" limestone. In addition, all shaft tips were to be base grouted. This comprised injecting a slurry grout at 3 foot centers to a depth of 30 feet below every shaft tip. "Heavily loaded structures" were limited to drilled shafts only, with the same requirements as for "moderately loaded structures". Estimated shaft capacities for 36 inch drilled shafts were 800 tons at a depth of 100 feet.

It was considered by Morris-Shea, that the use of large diameter Continuous Flight Auger (CFA) piles, together with drill rig instrumentation would allow a more cost effective foundation solution, while still achieving the strict settlement criteria.

Design Build Option:

Morris-Shea is at the forefront of CFA technology and construction practice in the USA. The ability of Morris-Shea's high torque CFA rigs to install piles to adequately support the design loads was not in question. The key to successfully utilizing this system was to identify and address changes in subsurface geology, namely the limestone elevation and competency at every pile location. Failure to do this would require a conservative "catch all" pile tip elevation to be set, in a similar manner to the original shaft foundation option.

The use of drill rig instrumentation to measure both drilling and concreting parameters provided the ability to

optimize pile length and provide quality assurance during pile construction. Key parameters such as drill depth, turntable torque, and drill rate are measured and displayed in-cab, allowing required pile tip depth to be verified on a pile by pile basis.

Measurement, and in-cab display of concreting parameters such as pumped volume, concrete pressure at the top of the auger, pull out rate, and overconsumption ratio also enable better control over pile construction.

Morris Shea proposed the use of 16-inch CFA piles with a working load of 100 tons in the moderately loaded structures. CFA piles socketed into the limestone, were considered to be technically superior than stone columns, and more cost effective than both stone columns and drilled shafts.

In the heavily loaded structures, 1 meter diameter CFA piles were proposed in place of 36-inch drilled shafts for working loads of 300 to 800 tons. In the few locations where the overburden sands and clays were sufficiently deep that CFA piles were not feasible, cased ahead drilled shafts were proposed.

The technical merits, cost, and schedule advantages of Morris-Shea's design build option were reviewed by the owner and his design consultants, and subsequently approved.

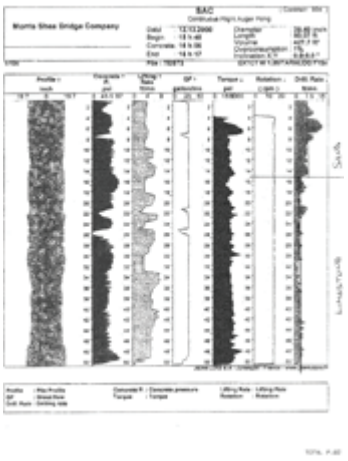
Supplementary Investigation:

To supplement the existing geotechnical study, Morris-Shea contracted Professional Service Industries to perform an additional 20 SPT borings to depths of 100 to 150 feet deep. The purpose of the borings was to fill in gaps in the original boring coverage, specifically in the areas of heavily loaded structures, and provide known profiles to allow correlation of soil types and strength variation with CFA drill parameters. In addition, areas were identified where the limestone was sufficiently deep that conventional shafts were required.

Load Test Program:

While the base bid drilled shaft option required no load testing, Morris-Shea completed an extensive load test program to allow verification that the proposed alternate would work, and to enable optimization of pile lengths.

A total of 11 full scale static and Statnamic load tests were performed, with 3 static and 4 Statnamic tests on 1-meter diameter CFA piles, and 4 static tests on 16" diameter CFA



piles. The load test program confirmed the suitability of the upper limestone for foundation support of both moderate and heavy structures.

To allow determination of unit shaft friction and unit end bearing capacity values, multi-layered strain gauges were installed in all seven 1-meter diameter CFA test piles. The combined data from borings performed at the test pile locations, monitoring of drilling parameters during test pile installation, and unit friction values from load testing allowed the development of installation criteria that accounted for the potential variability during production pile installation.

Two 1000-ton static jacks were used, together with a 1600-ton load frame to perform static testing. A MEGADEC data storage system was used to monitor load cell, strain gauge, and LVDT measurements, backed up with dial gauges and jack pressure measurements.

A 16 Mega Newton mechanical-catch Statnamic devise was used for all Statnamic tests. A total of 2 single cycle and 2 multi-cycle tests were performed to supplement the static testing, and provide better coverage of the project site.

Installation criteria derived from load testing required minimum socket lengths in the limestone, with structure specific borings and drill rates being used to verify acceptability on a pile by pile basis.

Production Pile Installation:

Installation of the 398, 1-meter diameter CFA piles was performed with a Hitachi KH-180 base

crane fitted with a high torque mast and electrical turntable. With this system, a 1-meter diameter hollow stem auger is advanced to the required depth, prior to grout or concrete being pumped under pressure as the auger is withdrawn without rotation using 120-tons of line pull. The grout forms a monolithic column into which a reinforcement cage is inserted.

Production rates were on the order of 10 to 15 piles per day for 1-meter diameter piles, and 20 to 30 piles per day for 16" piles. On completion of concreting and reinforcement installation, the grout was dipped or air-lifted to the required cut-off elevation, up to 6' below working grade.

The 405 16" diameter CFA piles used in the moderately loaded structure areas, were installed by a similar Hitachi base machine with a high torque hydraulic turntable.

In areas of deep overburden, where high loads were present, cased ahead drilled shafts were used. This system uses a sectional casing to stabilize the bore as the soil and rock is drilled out and stockpiled. Upon reaching the required depth, the reinforcing cage is installed prior to concrete being placed via a tremie.

A Bauer BG36 was used for the drilled shaft installation. The BG36 has an available drilling and casing drive torque of 36 ton-meters. Average production was 2 to 3 shafts per day with lengths up to 100-feet.

As shown below, all 3 drill rigs were in production at the same time to provide schedule acceleration. All additional soils investigation, engineering, load testing and pro-

duction pile installation was completed approximately 3 months ahead of the proposed base bid schedule.

More Information:

For more information on Suwannee American Cement Plant Project, Design-Build, Drilled Shaft or CFA Piles, please contact:

estimating@morrisshea.com
205-956-9518

Morris-Shea Bridge Co., Inc.
609 South 20th Street
Irondale, AL 35210

www.morrisshea.com