Thank you for your support in 2014; may 2015 bring you health, happiness and prosperity.

Pile Dynamics, Inc.

GRL engineers, inc.

NEWSLETTER No. 77 - January 2015

DYNAMIC LOAD TESTING USING THE APPLE VIII

Ben White, GRL Engineers, Inc. and Martin Grem, PCL Civil Constructors, Inc.

The SC-41 Wando River Bridge project consists of the construction of a 2088 foot (636 m) long replacement bridge resting on 17 bents. This South Carolina Department of Transportation design-build project was awarded to PCL Civil Constructors and design-build team members ICA Engineering and Terracon.

The chosen foundation elements were drilled shafts which were designed to develop capacity primarily from skin friction in stiff elastic clay referred to as Cooper Marl. A load test shaft, required by contract and used for both design and technique approval, was constructed having a 78 inch (1980 mm) diameter permanently cased in the upper 25 feet (7.62 meters), including 5 feet (1.5 meters) constructed above grade, and a lower section of 72 inch (1830 mm) diameter uncased in the Marl for a total length of 82.5 feet (25.1 meters). The test shaft was installed to perform a load test to a maximum load of 6000 kips (26.7 MN) to substantiate the design assumptions regarding soil resistance. The design-build team was given the options of performing a bi-directional (O-Cell) load test, a rapid load test, or a high strain dynamic test. In this case, PCL chose the high strain dynamic load test as this method provided cost and time savings over the alternatives.

APPLE VIII Load Test System with 60 ton (54.4 MT) drop weight

GRL Engineers, Inc. was contracted to perform the high strain dynamic load test. GRL used their new APPLE VIII load test system which has a maximum drop weight of 80 tons (72.6 tonne) and a guide frame with stabilizer legs. A 60 ton (54.4 tonne) drop weight was chosen as, generally, it is recommended that the drop weight be 2% of the target test load for friction type foundation elements. A hydraulic clamp at the top of the frame transfers the weight of the ram from the lifting crane to the APPLE frame prior to free fall of the ram. The APPLE system was assembled and the test was performed with cranes and equipment used for the shaft installation, so no significant additional equipment was necessary to perform the dynamic load test.

The shaft was instrumented with 4 strain transducers and 4 accelerometers approximately 5 feet (1.5 meters) from the top of the shaft. Four inches (10 cm) of plywood and a 2 inch (5 cm) thick steel plate were placed on top of the shaft to cushion and distribute the impact. The high strain dynamic test consisted of impacts of increasing drop heights ranging from 0.7 to 5.5 feet (0.21 to 1.68 meters). The first 2 impacts with very low drop heights were applied to compress the cushion, and no permanent set was observed under these impacts. The permanent set under each subsequent impact was measured using a site level. The total set during the dynamic load test was just under one inch (25 mm).

The measured force and velocity curves indicated that the shaft sustained no significant damage during the test and stresses were less than 3500 psi (24 MPa) in compression and 300 psi (2.1 MPa) in tension, well below the accepted limits. CAPWAP® analyses were performed on the measured data. The total mobilized capacity from CAPWAP analysis increased from impact 3 to 4, but dropped for impact 5, along with an increase in observed set. This decrease in capacity is expected in sensitive soils when the shaft has been loaded past the point of plastic failure of the concrete/soil interface (often referred to as plunging failure) and indicates that the ultimate capacity of the shaft was reached during the previous impact. Therefore, it was determined from impact 4 that the ultimate capacity of this shaft was 4977 kips (22.1 MN).

In addition to total skin friction resistance and end bearing, the CAPWAP analyses provided unit skin friction resistances over the length of the shaft for selection of design parameters for production shafts. In this case, the CAPWAP results indicated unit skin friction resistances ranging from 2.1 to 3.7 ksf (101 to 177 kPa) and a unit end bearing resistance of 32 ksf (1530 kPa) in the Cooper Marl. Finally, the CAPWAP analysis generates a simulated load versus settlement curve for each impact, similar to the results of a standard top down static load test.

The results of this high strain dynamic test confirmed many of the design assumptions for this project; however, a few shafts are likely to be extended based on the results of the dynamic load test. While the test shaft was loaded beyond its ultimate capacity, the shaft was not damaged during the load test. The load test system was assembled, the test performed, and the load test system was disassembled in less than 2 days. High strain dynamic testing provided a cost and time effective solution to the design-build team and provided the results needed to evaluate the design of their proposed foundations.

Highlights of the 2015 Calendar of events (Jan.-June)

More events, info and registration forms at www.pile.com/events

PDI and GRL Workshops, Seminars and Proficiency Tests:

February 20 in Seattle, WA, The Washington Branch Office of GRL Engineers presents the seminar "Quality Assurance and Testing Techniques of Drilled Foundations", with Marty Bixler and Pat Hannigan. **Details forthcoming**.

February 23 in Portland, OR, The Washington Branch Office of GRL Engineers presents Seminar on "Quality Assurance and Testing Techniques of Driven Piles" with Marty Bixler and Pat Hannigan. **Details forthcoming**.

February 25-27 in Calgary, Canada, in collaboration with the Pile Driving Contractors Association (PDCA) and Calgary Geotechnical Society: Seminar on Deep Foundation Integrity Testing and Wave Equation Analysis, High Strain Dynamic Foundation Testing Workshop and Proficiency Test.

May 6-7 in Amsterdam, The Netherlands, in collaboration with GSP: High Strain Dynamic Foundation Testing Workshop and Proficiency Test and Wave Equation Analysis of Pile Driving (GRLWEAP) Workshop.

May 13-15 in Jacksonville, FL, in collaboration with PDCA: Seminar on Deep Foundation Integrity Testing and Wave Equation Analysis, High Strain Dynamic Foundation Testing Workshop and Proficiency Test.

PDI Webinars: Learn without leaving your desk:

January 20 (no registration fee): The new 8th generation (8G) Pile Driving Analyzer® with Brent Robinson and Ryan Allin

January 21 (no registration fee): CAPWAP® Software Overview with Dr. Frank Rausche

February 10: Quality Control of Augered Cast-In-Place / Continuous Flight Auger Piles with George Piscsalko.

March 3: Thermal Integrity Profiling of Concrete Foundations with George Piscsalko

April 7-8: Fundamentals of High Strain Dynamic Foundation Testing (PDA) with Ryan Allin

May 5, 6, 12 and 13: Advanced Applications of CAPWAP® 2014 Software with Brent Robinson.

June 9, 10, 16 and 17: Wave Equation Analysis of Piles using GRLWEAP with Dr. Frank Rausche.

Other Learning Opportunities

Dr. Frank Rausche will present the Osterberg Lecture and Mohamad Hussein and Garland Likins will present short courses at the March 17-21 International Foundations Congress and Equip Expo (IFCEE 2015) in San Antonio, Texas. Make sure to also visit GRL at Booth 626 and PDI at Booth 422.

Garland Likins will be a keynote speaker at SEFE 8, taking place June 23-25 in São Paulo, Brazil and organized by ABMS, ABEF and other Brazilian organizations. Also visit PDI Representative Carmix do Brasil at booth 136.

Please visit the GRL Booth at the Florida Transportation Builders' Association Annual Construction Conference, February 17-18 in Orlando, Florida.

Frank Rausche, Ph.D., P.E. has been selected as the DFI 2015 Osterberg Lecturer

The Deep Foundations Institute has announced that Frank Rausche, Ph.D., P.E., was selected as the DFI 2015 Osterberg Lecturer. Dr. Rausche will deliver this prestigious lecture on March 19, 2015 during the International Foundations Congress and Equipment Expo (IFCEE), with the theme "Load Testing of Deep Foundations: Developments, Applications, Results".

ASTM Standard for Thermal Integrity Profiling

The American Society for Testing and Materials has issued a new standard, ASTM D7949 – 14, "Standard Test Methods for Thermal Integrity Profiling of Concrete Deep Foundations". This Standard provides "minimum requirements for thermal profiling of concrete deep foundation elements" and may now be purchased from ASTM at www.astm.org/Standards/D7949.htm?A. The Scope of the Standard states that "the thermal profile resulting from the early curing of concrete can be used to evaluate the homogeneity and integrity of the concrete mass" and mentions its use in "bored piles, drilled shafts, augered piles, diaphragm walls, barrettes and dams" and other similar structures. The Thermal Integrity Profiler (TIP) manufactured by Pile Dynamics meets the requirements of ASTM D7949. TIP makes it possible to quickly scan the early curing process for local relatively cool temperatures resulting from reduction of cement content, which could indicate local defects. The effective radius and hence concrete cover as a function of position along the shaft can be estimated from this method.

10th International Conference on Stress Wave Theory and Testing Methods of Deep Foundations

The 10th International Conference on Stress Wave Theory and Testing of Deep Foundations (Stress Wave 2016) will be held at the University of Massachusetts at Lowell (near Boston, Massachusetts, USA) on June 1-3, 2016, with short courses and workshops on May 31, 2016. This conference is held every four years and is the most important forum of discussion of state of the art foundation testing theories and applications. Professionals in this field are strongly encouraged to submit a paper. Abstracts will be received from January 5, 2015 to March 2, 2015. SW 2016 is conducted in partnership with the ASTM D-18 committee and the proceedings will be published as an ASTM Selected Technical Paper. For more information visit http://sw2016.org/.

GRL welcomes new engineer

Jakub Skodowski, E.I., who joined GRL in 2013 as a co-op, is now an engineer with the Central Office of GRL.

New Model of Thermal Integrity Profiler (TIP)

Pile Dynamics has released a larger model of the Thermal Integrity Profiler. It has the same functionality as the original TIP with a considerably larger, sunlight viewable LCD screen, making it easier to use. The analysis software, TIP Reporter, has been updated as well.

www.pile.com: *the portal for deep foundation testing services, instruments and software*

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