



Information gathered by the engineers of
Goble Rausche Likins and Associates, Inc. and *Pile Dynamics, Inc.*

"CLASS A" CAPACITY PREDICTIONS by George Goble

In our May 1999 Newsletter No. 34 (posted on our website or available in hard copy), we discussed potential problems associated with performing and evaluating pile load tests. This time we will present a Class A Prediction case (a capacity prediction without prior knowledge of the load test).

On October 10, 1999, a field demonstration of pile driving for fifty Denver area engineers was performed in the yard of Lawrence Construction Company in Denver, CO to promote driven piles. Two anchor piles were driven to refusal prior to the demonstration. On the demonstration day, the test pile was to be driven with Pile Driving Analyzer® (PDA) testing. After completing the test pile installation, a static load test was to be quickly assembled and performed. This plan would give a capacity correlation between the PDA test and the static load test.

As we enter a new era ...

*Dear Clients and Readers,
We thank you for your holiday wishes and
another year of fruitful cooperation. May
the coming year bring us all peace,
health and success.*

The pile was a 40 ft (12.2 m) 12HP53 section of A-36 steel. A soil investigation revealed interbedded weathered claystone-sandstone ($N > 100$) overlain by about 30 feet of silty sand ($N = 12$). This soil profile is common in the Denver area.

The pile was driven a few feet into the bedrock with a Linkbelt 520 double acting diesel hammer (energy rating 26.3 kip-ft or 35.7 kJ). A wave equation analysis prior to the test suggested that, at a blow count of 10 blows per inch (400 blows/m), the pile capacity would be 200 tons (1,780 kN) and the maximum driving stress 27 ksi (185 MPa), well below a maximum acceptable value of 90 percent of the pile yield stress. Note the Engineering News formula (ENR) yields an ultimate capacity of 263 tons (2340 kN) assuming a factor of safety of 2.

The pile was driven to a blow count of 10 blows per inch and PDA dynamic measurements were made during the entire driving process. End of Drive Case Method capacity was 140 tons based on an assumed damping of $J = 0.8$ (selected by GRL Colorado's Jay Berger based on his experience with similar soils). The maximum compression stress measured at the pile top was 23 ksi (160 MPa). A CAPWAP analysis, performed immediately following pile installation, indicated 130 tons (1160 kN) capacity. All results from GRLWEAP, Case Method, and CAPWAP were presented to the entire audience during lunch, while the static load test was assembled. These results appear on Table 1.

The pile was statically tested after a two hour wait. Time pressure was great to avoid holding the attendees any longer than absolutely necessary. GRL engineers attached the displacement measuring system, consisting of two dial gages. A load cell was not available so load was measured only by reading the jack pressure. To reduce the time to perform the static test, a modified quick test procedure was chosen. First a load of 40 tons was applied, then 20 tons were added, followed by

additional 10-ton increments to failure, all at five minute time intervals. The results of the static test are shown in the figure 1 below with the CAPWAP predicted static load test curve.

ENR	263 tons; 2340 kN
Standard GRLWEAP	200 tons; 1780 kN
Case Method, end of drive	140 tons; 1250 kN
CAPWAP	130 tons; 1160 kN
Static test	142 tons; 1260 kN

The differences between CAPWAP predicted and measured static load test curves are due to a combination of effects. The CAPWAP result assumed the full pile length. In reality about 2 m (6 ft) were cut off prior to the static test thus making the pile stiffer. The CAPWAP set should thus be about 15% lower than shown. On the other hand, the rapid static loading procedure and the skipping of some of the lower load increments caused the static test to be stiffer than it would otherwise have been. A slower application of loading would produce additional displacement for the same applied load. In practice, the CAPWAP pile stiffness model is often more accurate than any measurement can be due to the difficulty of making the reference for the displacement readings independent of the loading setup. The PDA and CAPWAP ultimate load predictions compared very favorably to the static test failure load considering the load uncertainty in the static test due to lack of a load cell.

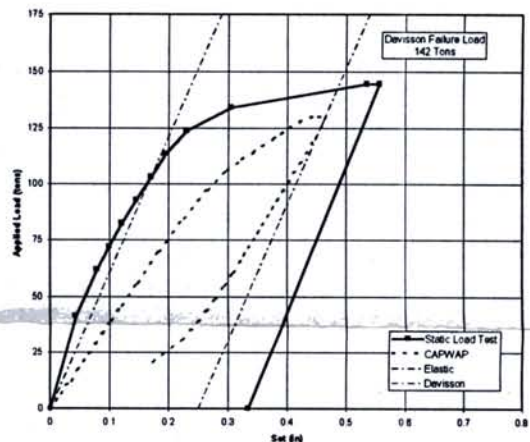


Figure 1

In summary, GRLWEAP over-predicted the pile capacity, primarily because of a low actual hammer performance. The Class A Predictions of Case Method and CAPWAP were 2 and 9% lower than the static test capacity, respectively. However, the static load was measured by hydraulic pressure which often indicates slightly higher loads because of jack friction. Differences between dynamically predicted and statically measured sets were at most 0.16 inches (4 mm).

CAPWAP capacity and soil stiffness also may have been low compared to the static test because of soil setup during the two hour load test preparation. In normal practice some time would be allowed between installation and testing such that soil strength gains (setup) or losses (relaxation) could be more accurately assessed by the dynamic testing.

PITTSBURGH, PA COMPLETES FOUNDATION WORK ON TWO NEW STADIUMS

Pile Dynamics is proud to have contributed to the successful completion of the foundation work of the PNC Park, home to the Pirates, Pittsburgh's baseball team, and also to the Steelers' Football Stadium. Both structures are supported by a total of over 6,000 augercast piles. The Pile Installation Recorder for Augercast Piles (PIR-A) was specified to be included on each rig installing augercast piles to assist in the installation process and document the quality of the foundation. At the peak of construction, PIR-A units were monitoring five active augercast piling rigs. The PIR-A graphics display gave information to the operator during the critical auger withdrawal phase and results were printed for each pile on site immediately upon completion of the pile.



DYNAMIC TESTING CERTIFICATION
Foundation QA Pty Ltd is an Australian company formed specifically to provide assistance to users of high-strain dynamic pile testing services worldwide. The company is headed by Dr. Julian Seidel who has 17 years experience in

dynamic pile testing practice, consulting, peer review, education and research. Foundation QA has developed a two-part examination to independently and objectively test the abilities of engineers working in the field of dynamic pile testing. Part A examines issues associated with good practice, procedural knowledge and data quality, including the collection of good data and recognition of bad data. Part B examines issues relating to data interpretation, including pile stresses, pile damage, capacity and hammer performance. Certificates will be issued to those passing the examination, and their names and company affiliation will be listed on their website (www.foundationqa.com). This website contains additional information about the certification test. It is anticipated that many regulatory agencies will adopt this certification as part of their quality assurance procedures.

NEW HONG KONG STANDARD PROPOSED

According to a recent newspaper article, all new buildings in Hong Kong would have their foundation piles checked under a plan proposed by the Building Department. The move comes after the discovery of several projects with substandard foundation work. Currently, Hong Kong requires that 5% of piles be inspected. The Hong Kong Construction Association will counter propose that engineers be hired "to check and monitor every stage when pilings are being laid."

GRL ENGINEER APPOINTED TO ASCE OFFICE

Mohamad Hussein, GRL Florida, was elected chairman of the American Society of Civil Engineers Geo-Institutes' Deep Foundations Technical Committee. The committee membership consists of deep foundations experts representing academia, design, and construction aspects of the industry.

Among the many activities of this committee is a big role in the organization of the upcoming International Deep Foundations Congress in 2002.

MONASH UNIVERSITY DEVELOPS PRODUCTS FOR ROCK SOCKETED PILES AND DRILLED SHAFTS

The ROCKET software predicts the load deflection response of the pile-rock interface and a pile-top load movement response for the complete pile.

SOCKETPRO allows unmanned inspection of side wall roughness and cleanliness.

Contact Monash Univ., Dept of Civil Eng., Wellington Rd., Clayton, 3168 Victoria, Australia, or call PDI for information.

READERS AND CLIENTS WRITE

Richard Yu, Pile Dynamics' representative in Malaysia: "My Pile Driving Analyzer model PAK S/N 1101 suffered quite a bit of damage due to an accident where a pile rolled over and hit the casing. (...) The good thing is that the PAK still works!"

(Note from Pile Dynamics: The robustness we talk about was indeed proven, but it turned out that Richard's PAK needed some repairs including a new case to put it back into mint condition).



CALENDAR OF EVENTS: YEAR 2000

- Feb 7-11:** Alabama: National Highway Institute Course on Design and Construction of Deep Foundations. Call (202) 366-1569.
- Feb 23-24:** Alabama: National Highway Institute (See above).
- Feb 24-26:** St. Petersburg Beach, FL: PDCA Winter Roundtable. Call (314) 275-7453.
- Mar 7-10:** New Jersey: National Highway Institute (See above).
- Mar 13-17:** Missouri: National Highway Institute (See above).
- Mar 27-31:** Cocoa Beach, FL: University of Florida; Fundamentals of Deep Foundation. Call (352) 392-1701 ext. 244.
- March (date to be announced):** New Jersey: National Highway Institute (See above).
- Apr 3-4:** Annapolis, MD: PDCA High Capacity Pile Seminar. Call (314) 275-7453. See enclosed flyer.
- Apr 11-14:** Oklahoma: National Highway Institute (See above).
- May 18-19:** Las Vegas, NV: ASCE Continuing Education (See above).
- Aug 3-8:** Denver, CO: GeoDenver 2000. Call (800) 548-2723.
- Sep 11-13:** São Paulo, Brazil: Stresswave 2000 (Also a Dynamic Testing Certification Test Site). Call (55) (11) 3104-6412. See enclosed flyer.
- Oct 19-20:** Chicago, IL: ASCE Continuing Education (See above).
- Oct 5-7:** New York City, NY: Deep Foundations Institute (DFI) annual meeting. Cal (201) 567-4232.

GRL

Goble Rausche Likins and Associates, Inc.

Main Office: Cleveland, Ohio

Branch Offices: California • Colorado • Florida • Illinois
North Carolina • Ohio • Pennsylvania

Phone: 216 831 6131

Fax: 216 831 0916



Pile Dynamics, Inc.
4535 Renaissance Parkway
Cleveland, OH USA

e-mail: info@pile.com

Web page: www.pile.com