



GRL NEWSLETTER

No. 31

INFORMATION GATHERED BY THE ENGINEERS OF
GOBLE RAUSCHE LIKINS AND ASSOCIATES, INC.

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GRL TESTS DRILLED SHAFTS by Frank Rausche

The last GRL Newsletter described the design of a dynamic load test system for drilled shafts. As a sequel, we report in this issue several drilled shaft tests which GRL engineers performed during the past summer facing a variety of pile, soil and load conditions. Curiously, 3 of the 4 drilled shaft test sites were stadiums; we also tested driven piles at several stadium sites in 1997. Based on the experience made to date, we estimate the cost of dynamic pile tests using the Pile Driving Analyzer® between 5 and 10% of static load tests with greater savings realized for larger test loads or as the number of tests increase.

The table below summarizes a few technical parameters and site conditions. The narrative explains what hammers were used. **Since drop hammer availability is critical, we would greatly appreciate any information on other available drop hammers, preferably with guides/leads.**

Site	Drop Weight	Drop Height	Top Shaft Diameter	Capacity Mobilized	No. Test Piles
	t (kips)	m (ft)	mm (inch)	MN (kips)	
Cleveland	3 (6.6)	2.0 (6.6)	406 (16)	2.2 (500)	8
Bowling Green	3 (6.6)	2.0 (6.6)	460 (18)	3.1 (700)	2
Milwaukee	20 (44)	3.8 (12.5)	1,070 (42)	22.0 (4800)	15
Arkansas	9 (20)	2.4 (8.0)	1,370 (54)	3.1 (700)	6

Browns Stadium, Cleveland, OH

Berkel & Company constructed **400 mm (16 inch)** diameter auger cast (CFA) piles of approximately **30 m (100 ft)** length in firm to very stiff silty clay. Specifications called for 2 static load tests and 8 dynamic tests up to the required ultimate capacities of 1.8 MN (400 kips). Berkel's Alan Roach coordinated with GRL Cleveland's C. Michael Morgano to conduct the dynamic tests which activated up to **2.2 MN (500 kips)** under six consecutive hammer blows. Permanent sets were less than 3 mm (1/8 inch) per blow.

In preparation for the tests, pile tops were extended with a 1.5 m (5 ft) long casing and high quality grout. Windows were cut into the casings for the attachment of 4 accelerometers and 4 strain transducers. The loading device was **GRL's 3 tonne (6.6 kip)** diesel ram, guided by its cylinder (see photograph). The former FEC 3000 hammer was prepared by Fritz Koltermann, Foundation Equipment Corp., Dover, OH for low compression "dry" (no fuel) impacts. Transferred energies under six drops (with up to 2 m (6.6 ft) drop height averaged 50% of the available energy. This is better than average pile driving hammer performance on concrete piles.

Bowling Green, OH

The tests were performed for Mr. Ken Applebee of United Foundations, a piling contractor in Peninsula, OH and by Neil Harnar, GRL Cleveland. The GRL 3 tonne hammer (see Browns Stadium) loaded the **460 mm (18 inch)** diameter auger cast piles of **6 m (20 ft)** average length. Soils consisted of clayey silt over small boulders and then rock. Test loads reached **3.1 MN (700 kips)** with no permanent set; the required ultimate capacity was 1.8 MN (400 kips).

Miller Park, Milwaukee, WI

The construction of this new stadium for the Southeast Wisconsin Professional Baseball Park District and the Brewers team required drilled shafts of **1050 mm (42 inch)** diameter, typically **15 to 20 m (50 to 60 ft)** long, socketed into limestone rock and with required ultimate capacities of 18 MN (4000 kips). The shafts were drilled and tremie cast under slurry. Osterberg load tests had shown that loads of at least 26 MN (6000 kips) could be applied to both rock socket and shaft bottom. For the dynamic tests, the piles were extended by **1.5 m (5 ft)** using a short section of casing as a lost form. Chicago GRL manager Pat Hannigan attached 4 strain transducers and 4 accelerometers as is now standard for all drilled shaft and large diameter pile testing.

Seasons' Greetings

The year is not yet over, in fact we are experiencing a beautiful Indian Summer after a most dynamic and eventful year. Since time goes by so quickly, we will not be able to send you another greeting before the holidays. We therefore want to take this opportunity to wish you a peaceful holiday season and health and prosperity for the next year. We hope that we will be able to further strengthen our business and personal relationship with you in the next year.



The tests were conducted with a hammer, ingeniously designed by drilled shaft contractor, Edward E. Gillen Co., using casings available at the site and steel scrap from a nearby plant. The 20+ ton ram was free released by an ICE vibro hammer's hydraulic clamps. Drop heights up to 3.6 m (12 ft) compensated for a relatively low energy transfer caused by the compressible nature of the steel scrap filling. GRL's Hasan Aboumatar calculated CAPWAP capacities up to **22 MN (4,800 kips)** for blows generating pile top sets between 0 and 5 mm. A total of 15 shafts were tested with up to 7 shafts in one day.



GRL's 3 tonnes Hammer with Cleveland Skyline

Arkansas Bridge

Kent Glesener, P.E. of Jensen Construction utilized Pileco's (Houston, TX) 9 tonne (20 kip) ram with drop heights of up to 2.4 m (8 ft). GRL Florida's Mohamad Hussein performed the Pile Driving Analyzer tests on 6 shafts, calculating capacities of up to **3.1MN (700 kips)**. The **15 m (50 ft)** long shafts had a top diameter of **1,370 mm (54 inches)** over the top 3.3 m (10 ft) and 1.2 m (48 inches) below that. Five shafts were tested in one day.

GRL Makes Energy Measurements on Long SPT Rods
by Jay Berger

Responding to a request from Jeff Farrar of the Bureau of Reclamation, GRL Colorado's Jay Berger and Pile Dynamics, Inc. developed an instrumentation package to measure force and velocity at any location along SPT drive rods up to 60 m (200 ft) in length. The 610 mm (2 ft) long NWJ SPT section was instrumented with two accelerometers on the inside and two full strain bridges on the outside. The package was fully waterproofed and pressure tested.

One objective of the field work at the US Army Corps of Engineers' Terminus Dam in the Central Valley of California, was the assessment of energy losses in very long SPT drive rods. The SPT results are used to study the liquefaction potential of native soils below the earth fill dam. A model PAK Pile Driving Analyzer was used to simultaneously capture data both from the downhole instrumented section and from the top of the SPT drive rod. The measurement quality was excellent and data reduction was greatly simplified by the PDA's ability to store all eight channels of data in one data file. GRL Cleveland's Neil Harnar assisted with these measurements and also acquired data with PDI's new digital Hammer Performance Analyzer (HPA), consisting of a RADAR antenna and a Windows programmed PC. This advanced digital technology greatly improves and simplifies the processing of ram impact velocity data from the HPA.

News from Pile Dynamics

Cross hole sonic logging has become a widely accepted integrity testing method for large diameter drilled shafts. PDI has recognized the potential of this integrity test method and now offers for sale the UMQA4 (Ultrasonic Material Quality Analyzer), built as the successor to the widely used TCP3 by Micrologica, to clients in the Americas and Europe. PDI and GRL engineers have already used the equipment on several jobs with good success and can offer training to others who purchase the UMQA4.

Dr. Liqun Liang has joined PDI after completing his doctoral thesis (see ASTM Geotechnical Testing Journal, Sept. 97: "The Use of Digital Image Processing in Monitoring Shear Band Development") at Case Western Reserve University. Working for PDI, Dr. Liang has already completed a digital processing capability for HPA ram impact velocity measurements. The system not only records and processes the data, including statistical summaries, it even checks and corrects data should the RADAR antenna miss a data point. An application has been described by Jay Berger in this Newsletter.

GRLWEAP News

Version 1997-2 has now been shipped, correcting certain non-uniform ram stiffness values in SI units of the previous 1997-1 version. International users had been immediately notified by fax about this problem. We urge all users to ensure that they install the corrected version which contains additional hammer and driving system data. Also, please keep us updated regarding your address and fax/phone numbers.

GRL is now working on the Windows version of GRLWEAP; we hope to release it in 1998.

1997-1998 CALENDAR OF EVENTS

INTERNATIONAL

1998

- Mar 22-25 2nd International Conf. On Engineering for Calcareous Sediments, Bahrain. Contact Khalil Al-Shafei, Fax: +966-3-873-1183.
- Jun 15-17 7th International Conf. On Piling and Deep Foundations, Palais Ferstel, Vienna, Austria. Contact Caroline Prescott, Westrade Group, Ph: +44-1923-778311.

USA

1997

- Nov 3-7 FHWA Workshop on Design and Installation of Impact Driven Piles, in Harrisburg, PA. Contact Jerry DiMaggio, FHWA, Ph: 202-366-1569, Fax: 202-366-3378.

1998

- Jan 21-22 FHWA Workshop on Design and Installation of Impact Driven Piles, in Albany, NY. Contact Jerry DiMaggio, FHWA, Ph: 202-366-1569, Fax: 202-366-3378.
- Feb 4-6 Seminar on Design and Installation of Impact Driven Piles, at University of Delaware, Contact Jerry DiMaggio, FHWA, Ph: 202-366-1569, Fax: 202-366-3378.
- Feb 9-10 ASCE Continuing Education, "Deep Foundations: Design, Construction and Quality Control", Boston, MA, Contact ASCE, Ph: 800-548-2723, Fax: 703-295-6132, E-mail: conted@asce.org
- Feb 19-21 PDCA Roundtable in Norfolk, VA, Contact Pile Driving Contractors Association, Ph: 314-275-PILE(7453) or Fax: 314-576-7989.
- Mar 8-15 4th International Conf. On Case Histories in Geotechnical Engineering. Contact Prof. Prakash, University of Missouri-Rolla, Fax: 573-341-4992
- Mar 17-18 ASCE Continuing Education, "Deep Foundations: Design, Construction and Quality Control", Los Angeles, CA, Contact ASCE, Ph: 800-548-2723, Fax: 703-295-6132, E-mail: conted@asce.org
- Mar 24-25 FHWA Workshop on Design and Installation of Impact Driven Piles, in Hutchinson, KS. Contact Jerry DiMaggio, FHWA, Ph: 202-366-1569, Fax: 202-366-3378.

Modern Mathematics (from the Internet)

Remember: Power = Work/Time
and Time = Money
and Knowledge = Power
Thus Knowledge = Work/Money
or Money = Work/Knowledge

This proves: the less you know, the more money you will make, or, ignorance is bliss. (Un)fortunately, GRL's business is built on the premise that the more we know, the better.

created by Dr. Julian Seidel of Monash University, Melbourne, Australia who is on a sabbatical in Cleveland. The presentations are also useful for teaching and training purposes. Although not yet complete, several lectures can already be obtained for a modest cost.

Following the Users Day and seminar in Hamburg, Florida's Mohamad Hussein traveled to Istanbul to conduct workshops for engineers from various parts of Turkey and PDI representative Erke dis Ticaret Ltd, Sti.

ASCE Continuing Education Course

As part of ASCE's Continuing Education Series, a two day course entitled "Deep Foundations: Design, Construction and Quality Control" will be offered in Boston in February and in Los Angeles in March, 1998. Instructors will be Dr. G. Goble and M. Hussein of GRL and Dr. Dan Brown of Auburn University (see Calendar Of Events).

Representations

Richard Yu of Soil Dynamics, Kuala Lumpur, Malaysia (Ph: +60-3-784-6348, Fax: +60-3-784-6400) is now the exclusive representative for Malaysia and Vietnam.

PDCA Seeks Engineering Members

The Pile Driving Contractors Association's mission for driven piles includes:

- Promotion of driven piles
- Support of educational programs
- Support research
- Improve codes, procedures, standards
- Raise standards of industry

For further information, please phone: 314-275-PILE(7453) or fax: 314-576-7989

Also see Roundtable announcement in the "Calendar of Events".

New-Additional E-Mail Addresses

Contact GRL and PDI at the following e-mail addresses, the latter is preferred for data transmission: Info@pile.com
Pile@cyberdrive.net

Please visit our web site at: <http://www.pile.com>

1997 PDA Users Days, Seminars, Presentations

In August in Cleveland, OH and in September (following the Intern. Conf. On Soil Mechanics and Foundations) in Hamburg, Germany, GRL/PDI held PDA Users Day for exchange of views on experiences and developments in pile testing. Windows based PDA software generated great interest for clients who also made valuable suggestions for additional features.

Also in Hamburg, a general seminar was held on pile testing methods. Standards and procedures of pile and drilled shaft testing in different countries were presented by representatives of Brazil, Denmark, Sweden, Germany and USA. The lectures featured Power Point Presentations

GRL

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