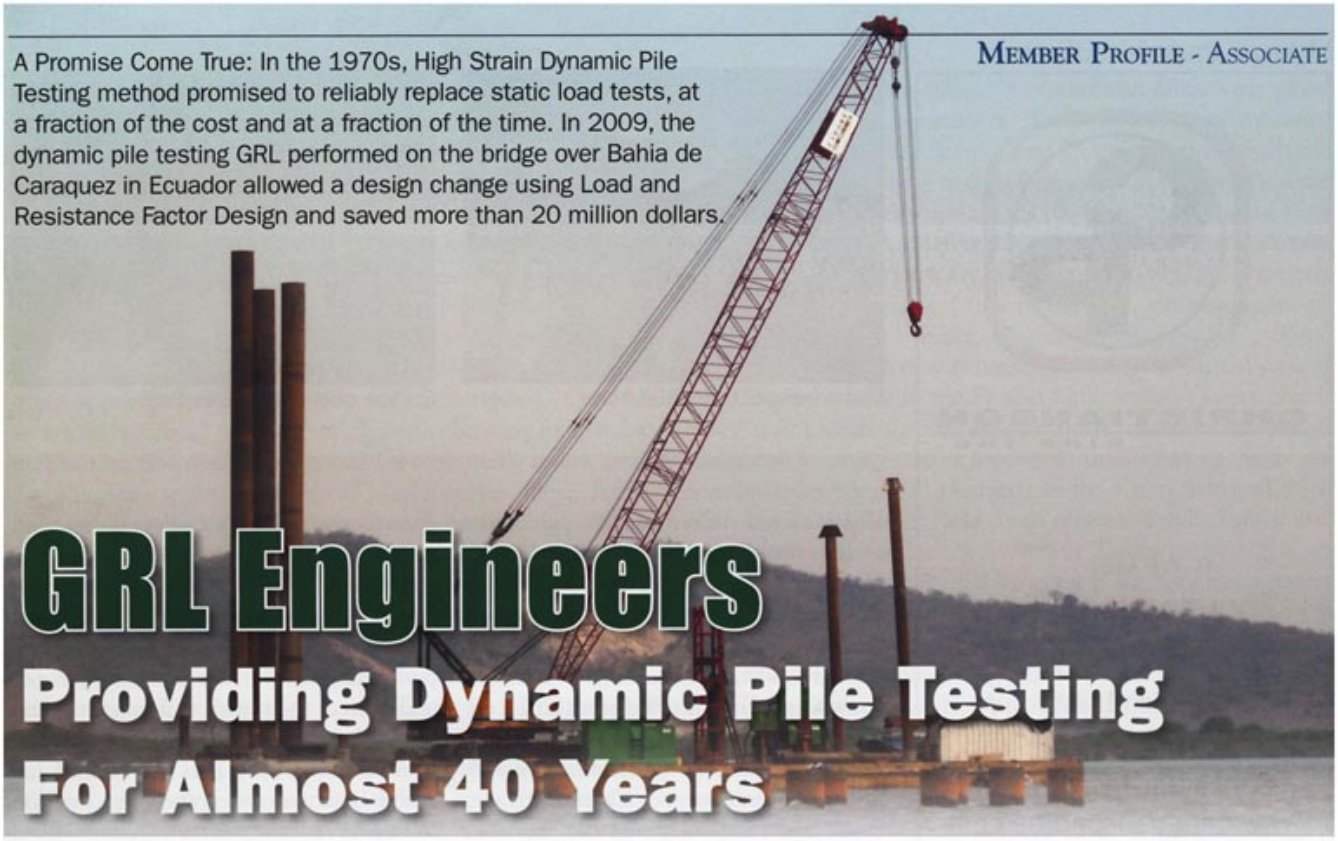

A Promise Come True: In the 1970s, High Strain Dynamic Pile Testing method promised to reliably replace static load tests, at a fraction of the cost and at a fraction of the time. In 2009, the dynamic pile testing GRL performed on the bridge over Bahia de Caraquez in Ecuador allowed a design change using Load and Resistance Factor Design and saved more than 20 million dollars.

GRL Engineers

Providing Dynamic Pile Testing For Almost 40 Years

By Gina Beim, P.E.

Disco music was all around, the US was celebrating its bicentennial, and Apple Computers had not even been incorporated yet. But the company now known as GRL Engineers was already born - it was the year 1976.

Four years before, the Journal of Soil Mechanics and Foundations Division of the American Society of Civil Engineers had published "Soil Predictions from Pile Dynamics" (by Rausche et. al). That paper was fundamental in disseminating to the geotechnical community the new method of pile testing being developed at the Case Institute of Technology in Cleveland, Ohio that resulted in the Pile Driving Analyzer® (PDA). The High Strain Dynamic Pile Testing method promised to reliably replace static load tests, at a fraction of the cost and at a fraction of the time.

Soon after, the rotary phones began to ring with inquiries about high strain dynamic pile testing. Frank Rausche and Garland Likins did practically all the testing in the early years as they covered the whole country. Too bad frequent flyer miles hadn't been invented yet! Not much later they hired part time secretary Marcia Giterman to join them in a small office atop a grocery store in Cleveland Heights, Ohio. Marcia, who later became a full time office manager, is now semi-retired but still consults for the company. She reminisced: "At first, we only had two pile testing jobs at a time, so we would refer to them as 'the Ohio job' and 'the Alaska job', and all the job reports fit into a single filing cabinet".

Fast forward to 2010. There are still jobs in Ohio and Alaska, large and small. In fact, the Ohio office of GRL will be part of the design-build team for Cleveland's new "Innerbelt Bridge", the largest single transportation investment in Ohio's history. And the installation of the piles of a small boat harbor in Alaska was recently analyzed with GRLWEAP (the time tested program of wave equation analysis of pile driving).

The difference from then to now is that there are a lot more than two pile testing jobs at a time. GRL now employs 27 engineers, and it is not uncommon for 20 of them to be either on the way to, at the job, or on the way back. When they are not busy testing, they are in one of GRL's offices, thoroughly analyzing the field data and finishing their reports to clients.

That's offices, plural: instead of the one small office of the 1970s, GRL now has offices in Pennsylvania, North Carolina, Florida, Louisiana, Colorado, Ohio, Illinois and California, and recently moved its Central Office to a 41,000 square feet facility it shares with sister company Pile Dynamics, Inc. in Cleveland, Ohio.

Around the time that this article was being written, Murali Ravi (GRL PA) was calibrating SPT rigs at the JFK airport, Darrell Fortune (GRL NC) was performing cross-hole sonic logging on the foundations of a bridge in North Carolina, Anna Klesney (GRL CO) had a pile integrity testing job in San Antonio, and Camilo Alvarez (GRL CA) had flown to Venezuela to conduct a dynamic load test on a bridge over the Orinoco River (he used the PDA and a 60 ton drop weight, the largest in Latin America, to test up to 6000 tons pile bearing capacity). All this was happening while Al Ziai (GRL Central Office) was testing piles in a part of Northwestern Canada so remote that he had to sleep at a camp site where bears were frequent visitors. (read the compliment Al got after his return), and Pat Hannigan (GRL IL) was safe from bears, sitting in his office in a Chicago suburb, monitoring pile driving in Galveston, Texas, and Milwaukee, Wisconsin, with SiteLink™.

These are just a few of the many engineers who make up the new generation of GRL. Leading the various regional offices are Mohamad Hussein (Past Chair of the Deep Foundations Committee of the American Society of Civil Engineer's Geo-Institute and the Director of ASCE's nation-


Venezuela 60 ton PDA test


Bridge over Escambia Bay

ally offered Continuing Education Course on Deep Foundations Design, Construction, and Quality Control), Pat Hannigan (prime author of the Federal Highway Administration's publication "Design and Construction of Driven Pile Foundations"), Scott Webster (GRL's offshore manager as well as its most experienced unknown foundation tester), Michael Morgano and Camilo Alvarez. Frank and Garland paved the way to a pile testing industry that helped optimize design, refine driven pile installation methods and speed construction. GRL's outstanding senior engineers are following in their footsteps, expanding the application of dynamic testing and spreading their knowledge – be it by presenting at conferences, collaborating with universities, writing journal papers or manuals, supporting colleagues all over the world with advice and analysis reviews and/or by introducing dynamic foundation testing to other engineers in training sessions and workshops.

Even though a considerable percentage of GRL projects still involves dynamic monitoring of driven piles with the PDA and CAPWAP® (see CAPWAP sidebar), GRL now provides many other services, such as integrity testing, cross-hole sonic logging, wave equation analysis, evaluation of unknown foundations, evaluation of SPT equipment and dynamic testing of drilled shafts and augered cast-in-place piles with its APPLE system. The various GRL offices are all equipped to perform the whole range of services that GRL offers, while remaining attuned to the realities of the region each serves.

"The bulk of what the GRL Illinois office tests are H piles" – says Pat Hannigan – "and we test the majority of them using wireless. (Pat is referring to using Smart Sensors, which, instead of transmitting data to the PDA by cables, do so with wireless radio transmitters). The contractors like it because they don't need to climb the leads to install the accelerometers and strain transducers, it's easy to put them on with the pile on the ground, and protect them with stiff foam padding while the piles are being hoisted." The Illinois office only uses the traditional (cabled) sensors when they are conducting an APPLE test, such as a test on belled shaft where excavation associated issues raised capacity concerns.

The Ohio and Pennsylvania offices, both under the helm of Michael Morgano, are unique in the highly variable soil conditions of their territory. Michael and his team test from short (10 to 20 ft) H piles driven into hard rock in the Buffalo area, where concerns with driving stresses often govern the installation requirements, to 300 ft long steel piles in Syracuse, where stresses aren't an issue, but where it is sometimes challenging to mobilize the required capacity. They deal with serious relaxation potential in the weathered shales around Pittsburgh, and with fairly straightforward jobs on the East Coast, where there is a prevalence of pipe piles driven into sands. In West Virginia, most of the Ohio office workload involves investigating the quality of drilled shafts using cross-hole sonic logging.

Florida is the longest continuously operating office of GRL, serving the South Eastern US and the Caribbean. Keeping with the design-build trend, that office provided dynamic testing services for the first (1992), the largest (I-595 corridor improvements) and the largest single bridge (Bridge over Escambia Bay, see photo) Florida DOTs Design-Build projects. In fact, says GRL Florida's Mohamad Hussein, "We are currently involved in most, if not all, such projects, either as

part of the design-build team or as part of the DOT's oversight team". Mohamad and his team work on many private sector jobs as well: from piers and cruise terminals in the Caribbean to high rise condominiums in Miami, and on essentially all Orlando area amusement parks.

Departments of Transportation are often interested in determining the depth of bridge foundations for which construction records are no longer available. The North Carolina office of GRL is currently helping the DOT of that state gain information on 150 bridges. This effort follows a previous stint in 2006 when approximately 100 bridges were investigated. GRL has an entire "toolbox" for this type of work, choosing from induction testing (for steel piles), parallel seismic tests, or low strain dynamic tests (pulse echo, or PIT) on concrete piles. Testing unknown foundations requires engineers to be resourceful, as the existing superstructure often makes data acquisition and interpretation challenging. It is, however, a promising field: while the DOTs resort to these tests while evaluating bridges for scour, the reuse of existing foundations is of growing interest to sustainability minded engineers, particularly in the congested urban areas of Europe.

In addition to providing foundation testing services across the United States, GRL has a significant testing presence on offshore pile testing projects. Pile driving is an important and challenging part of the construction of offshore oil platforms as well as of the installation of offshore wind farms. In both situations, long, large and extremely expensive piles are driven to deep penetrations in a difficult environment, often with severe physical and time constraints. Scott Webster has managed GRL's Offshore Services for the past 15 years, during which the pile foundations of more than 100 offshore oil platforms – some up to 20 ft in diameter and up to1400 ft in length - have been tested with the PDA, often requiring the use of special underwater sensors. Scott counts on the entire team of GRL Engineers to rotate the staffing of Offshore Services, since assignments often require several weeks on a construction barge. Going offshore for the first time is a rite of passage for virtually every GRL Engineer, be it in the Persian Gulf, Indian Ocean, North Sea, Arctic Ocean, Brazil, Gulf of Mexico...wherever oil and gas is about to be prospected or produced. In 2010 alone, Scott has coordinated work on 13 platforms in the Karan field and three platforms in the ZULF Field, both offshore Saudi Arabia, and one platform in the Black Sea, offshore Turkey.

Maybe the secret of GRL's success is the way its engineers feel about the work of its founders: "It's been 25 years and I'm still amazed at how much information I can obtain from looking at a graph," said Michael Morgano, a partner in GRL and manager of the Ohio office who's been with GRL since 1985, while momentarily interrupting his CAPWAP analysis to contribute to this article. "So much information about a pile that I can see instantly – just by looking – stresses, capacity, hammer performance, any damage ...it's such a far cry from a static test." And it all started as a research project at Case – pretty amazing. ▼

Photos courtesy of GRL Engineers, Inc.

SiteLink™ is technology through which GRL conducts Dynamic Foundation Testing from any of its offices. It eliminates scheduling conflicts and the travel of the engineer to the field to conduct the test, minimizing the time until report submittal. The GRL engineer monitors the job remotely, using software that tracks and controls the pile test.

CAPWAP® - Case Pile Wave Analysis Program - is the signal matching software program, originally developed by Frank Rausche as part of his PhD dissertation. It uses PDA data to calculate total bearing capacity as well as resistance distribution along the pile shaft and at the toe. Its results correlate very well with static load tests results. GRL Engineers perform at least one CAPWAP analysis per dynamic load testing job. On driven pile jobs GRL has recently begun to also perform iCAPTM – a simplified signal matching program that calculates bearing capacity during driving.

Dynamic pile testing offshore – PDA in the foreground

Spreading the knowledge: "I would (...) like to extend our sincere appreciation to Ryan Allin," said John R. Morris, Jr., P.E., from Morris-Flood Associates, LLC., adding, "Ryan worked shoulder to shoulder with us clearly demonstrating the features and functions of the equipment, the steps necessary to properly set up the equipment in the field, and assisting in executing the dynamic testing program for the project that we are working on. Ryan was a superb and knowledgeable teacher and was truly supportive, professional and hard working."

GRL Engineers, Inc. in brief

Specialty: Dynamic testing and analysis of deep foundations
In business since: 1976
Representative clients: Most US Departments of Transportation; Port Authorities; US Army Corps of Engineers; US Navy; construction corporations; foundation contractors; engineering consultants
President: Frank Rausche
Vice Presidents: Garland Likins, Mohamad Hussein, Pat Hannigan, Michael Morgano, Scott Webster Camilo Alvarez.
Number of engineers: 27

Offices:
Central 216.831.6131
California 323.441.0965
Colorado 303.666.6127
Florida..... 407.826.9539
Illinois..... 847.221.2750
Louisiana 985.640.7961
North Carolina 704.593.0992
Ohio 216.831.6131
Pennsylvania 610.459.0278
info@pile.com
www.pile.com/grl
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