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The Official Publication Of The Pile Driving Contractors Association - Fall 2002 - Volume 3, Number 4

The First Of Many Professors' Piling Institutes

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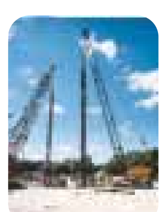

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In The Real World, The Picture Is A Little More Encouraging

From The President
By Jim Frazier

According to the media, the economic forecast for the immediate future is unknown and somewhat foreboding. Fluctuations in the market have investors running scared as business owners and consumers brace themselves for a recession. But out in the real world, I have found a much more encouraging picture.

This summer I attended the PDCA-sponsored conference, The Design and Installation of Cost-Efficient Driven Piles. Between the highly informative seminars, I was able to spend some time talking with the contractors, suppliers and exhibitors who attended the Conference. I was curious to see how general economic conditions were affecting their businesses. The dark and gloomy picture we seem to get from the news each night was not what is actually happening in our industry.

Most of the people I spoke with were fairly optimistic about the state of our nation. Contractors said they were either busy or business was picking up. Exhibitors echoed these sentiments, and their strong showing at the Conference also drove this point home. Perhaps the stock market is riding on a roller coaster, but our industry is not. This is a trend I hope to see continue.

The national economy was not the only financial item on my agenda to discuss during the summer months. At our last meeting of the Board of Directors, we voted to increase membership dues. Next year, contractor/associate member dues will be $650, and technical membership will be $95. We have not raised dues since 1997, but I still want to relay the reason for our decision.

The PDCA now sponsors three major industry events each year: the DICEP Conference, the Winter Roundtable and now the Professors' Institute. The Board has committed to holding at least two more Professor's Institutes, with the possibility of five total. I applaud this decision and have stated many times that educating the educators is a key building block in our fight to solidify the driven pile in the deep foundation industry. But these events require an enormous amount of resources. Although we have many generous sponsors, we still need additional funds to cover expenses. The increase in membership dues will assuage some of these expenses.

I would like to thank you for your support and participation in this Association and look forward to another successful year.

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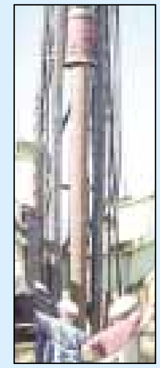
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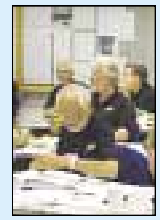
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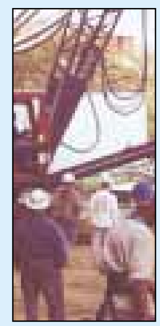
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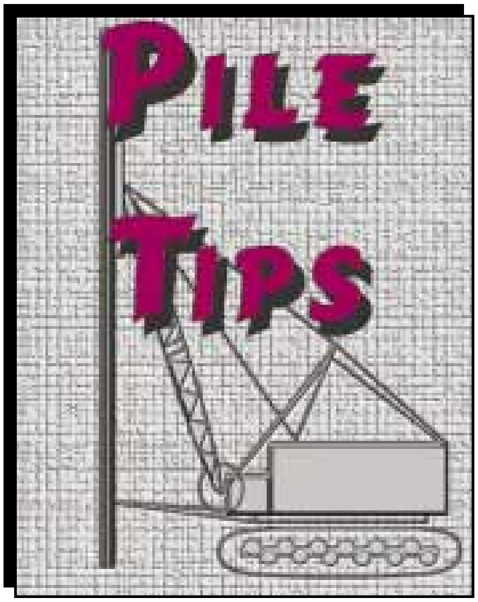

How Will Homeland Security Shape Tomorrow's Capital Projects?

Homeland Security will undoubtedly shape tomorrow's capital projects. But how? You are invited to find out.

At the request of the U.S. Department of Commerce, this year's FIATECH Capital Projects Technology Roadmap Workshop will begin with a session on the new priorities demanded by the need to improve homeland security. The Workshop is scheduled for Nov. 13 through Nov. 15 at the National Conference Center in Lansdowne, Va.

Participants also will continue the effort to develop detailed plans to address the technology challenges facing the construction industry.

FIATECH is a not-for-profit research consortium serving the construction industry. It was conceived by the National Institute of Standards and Technology and the Construction Industry Institute in 1999. Its mission is to achieve significant cycle time and life cycle cost reductions and efficiencies in capital projects, from concept to design, construction and operation.

For more information on the FIATECH Capital Projects Technology Roadmap Workshop, visit www.fiatech.org or contact Dr. Richard H.F. Jackson at (512) 232-9601.

ICS Adds Carp To Sales Team

International Construction Services, Inc., recently announced the addition of Bill Carp to its sales team.

Carp will work from the ICS office in Fair Oaks, Calif., and will be handling all sheet piling, H beams, wide flange beams, pipe for piling and foundation steel requirements in California, Oregon, Washington, Alaska, Hawaii and the Pacific Rim.

Carp has 25 years of experience in the piling and marine construction business on the west coast. He can be reached at (916) 989-6720 or (916) 952-0268, or by e-mail at billsnug@aol.com.

Gould Will Work In ICS' Illinois Office

International Construction Services, Inc., has announced the addition of Jim Gould to its sales team.

Gould will be working from the ICS office in Plainfield, Ill., and will be handling all sheet piling, H beams, wide flange beams, pipe for piling and foundation steel requirements in Illinois, Indiana, Ohio, Nebraska, Idaho, Montana, Colorado, Missouri, Kansas, Minnesota, Wisconsin, North Dakota and South Dakota.

Gould has15 years of experience in the piling supply business. He can be reached at (815) 609-9527 or (815) 922-9792.

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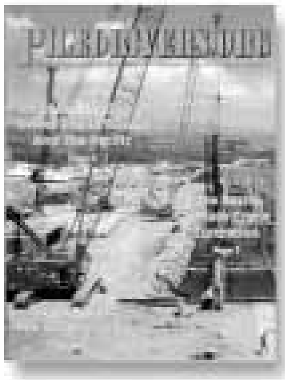

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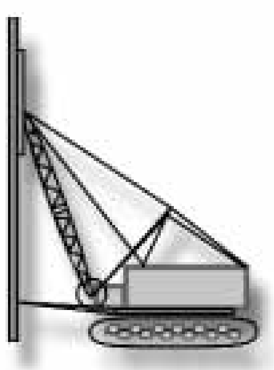

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The Effect Of Diesel Hammer Combustion Chamber Pressure On Tension Stresses In Concrete Piles

By George Goble and John White

Some piling contractors and engineers have observed that diesel hammers seem to have fewer problems with tension cracking in concrete piles than similar external combustion hammers. Certainly this view is not held universally, but it caused us to consider why such an effect might be true. Routine pile driving analyzer (PDA) measurements have indicated that the stress wave induced by a diesel hammer seems to decay more slowly than would be expected from a theoretical analysis. Since the difference between the two hammer types is primarily combustion chamber pressure, we asked the question, "What is the effect of the combustion chamber pressure on the stress wave immediately following impact?"

A small study was undertaken to investigate the stresses induced by the combustion chamber pressure immediately after impact. In the first phase, we sought to compare the induced stress wave from a diesel hammer and a comparable external combustion hammer. Due to the complexity of the problem, the only means of examining the question was to use wave equation analysis. All of the analyses presented here were made using GRLWEAP 2002-1.

In order to easily separate the induced (downward traveling) wave from the reflected wave, a 400-foot-long concrete pile was analyzed. Of course, such a long pile is unrealistic from a practical point of view, but it shows the input compression wave at the pile top without the effect of a reflected wave. A 12-inch square concrete pile section was used with an APE D-19-32 diesel hammer and an APE driving system with a three-inch-thick plywood pile cushion. The pile was embedded in the ground 20 feet with a total soil resistance of 100 kips. The rather large soil resistance was necessary to carry the total weight of the pile, hammer and driving system. Since only the downward traveling wave was of interest, the characteristics of the reflected soil resistance was of no consequence so long as it was not reflected back to the pile top on top of the induced downward traveling wave.

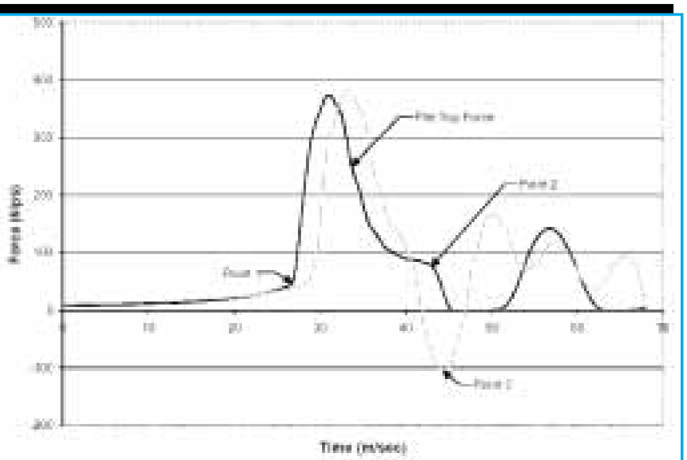

Figure 2 - Force Records for APE-D-19-32 Driving a 100-Foot-Long Concrete Pile

The force induced at the pile top by the APE D-19-32 is shown by the solid line in Figure 1. The force during the time shown in Sector A is the pile top force due to the diesel hammer precompression force. The ram has moved past the exhaust ports and is compressing the air in the combustion chamber and exerting a force on the pile top. Impact occurs at Point 1 on the curve, inducing a force that continues to Point 2. Sector B represents the force at the top of the pile from the time of impact to the time of ram separation. During this period pile penetration can be induced by the large force coming from ram impact. After about Point 2 the ram has separated from the impact block. Actually, the point where the ram and the impact block separate is not clearly defined in the force record. Sector C is the period from ram separation from the impact block to the arrival of the reflection of the impact wave back from the toe of the pile. The force during this time comes from the combustion chamber pressure.

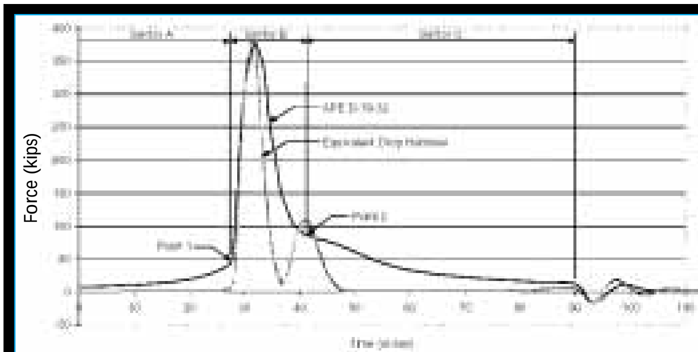

Figure 1 - Force Records for APE-D-19-32 and an Equivalent Drop Hammer at the Top of a 400-Foot-Long Pile

An equivalent drop hammer was created in GRLWEAP to compare with the diesel hammer results. The drop hammer ram was given the same geometry and weight as the ram and impact block of the APE D-19-32. This drop hammer was then dropped on the pile top using the same helmet and cushion as was used in the diesel hammer analysis described above. The stroke was adjusted to obtain the same peak impact force as was generated by the APE D-19-32. The force generated at the top of the pile by the drop hammer is shown in Figure 1 by the light line. The double-humped record at impact is probably

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Combustion

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due to the dynamic interaction of the ram, pile cushion and helmet. There is a slight similar effect at about the same time in the diesel hammer record in Figure 1, but almost all of the effect is probably smoothed by the combustion chamber pressure.

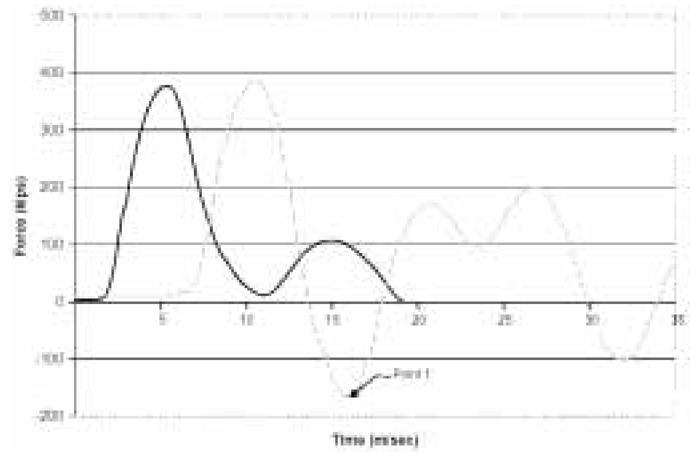


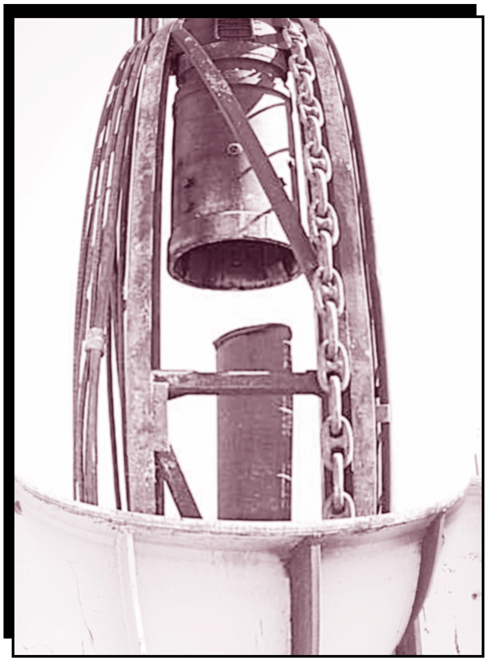
Figure 3: Force Records for the Equivalent Drop Hammer Driving a 100

After the impact, the drop hammer force stays constant at zero until the arrival of the toe reflection. The slow decay of the induced force after the impact event for the diesel hammer provides a continuing downward compression force input that when superimposed on the upward reflected tension stresses results in a reduced magnitude of net tension stresses along the pile. This reduced net tension is directly attributed to the long extended downward traveling compression wave coming from the combusted gas in the chamber.

A more realistic example was then analyzed using the same two driving systems with the same 12-inch concrete pile and the same soil resistance, but with a length of 100 feet. The results of the analysis of the APE D-19-32 are shown in Figure 2. The solid line is the force at the pile top. Point 1 is the beginning of impact and Point 2 is at the time when the tension reflection first arrives back at the top, causing the force to go to zero.

The force records for each analysis element along the length of the pile were examined to locate the element with the largest tension stress. It was located about 30 feet from the top of the pile in element 10, and the record for that element is shown by the light line in Figure 2. The maximum tension force was 106 kips or 736 psi at Point 3. (Note: This tension is not a usual problem as usually the prestress is larger than this so no true tension exists in the concrete itself.)

The last example analyzed used the equivalent drop hammer on the same 100-foot-long pile. The results of the analysis are shown in Figure 3. In this



case, the maximum tension force occurred in Element 21, about 30 feet from the bottom of the pile as shown by Point 1 in Figure 3. The maximum tension force was 166 kips or 1,150 psi, more than 50 percent larger than the same case driven by the diesel hammer.

This brief example showed the effect of the "stretching out" of the compression force in the stress wave by the normal operation of a diesel hammer. It can be expected that this effect can substantially reduce the possibility of tension cracking and damage in concrete piles driven with diesel hammers when compared with a similar external combustion hammer. This effect is determined by the usual GRL-WEAP analysis. This study shows that arbitrary limitations on pile-ram weight ratios often contained in pile driving specifications are not appropriate for diesel hammers. It is essential that a wave equation analysis must be made to evaluate possible tension stresses during the driving of concrete piles.

George Goble is principal of George G. Goble Consulting Engineer, LLC, of Boulder, Colo. He can be reached for questions or comments at (303) 494-0702 or goble@bridgetest.com. John White is president of American Piledriving Equipment of Kent, Wash. He can be reached for questions or comments at (253) 872-0141 or johnw@apevibro.com.

Announcing The 2002 PDCA

Driven Pile Project Of The Year Award

The Award
To acknowledge noteworthy contributions to the pile driving industry, PDCA will cite an outstanding project that uses driven piles to solve foundation problems. The 2002 winner will be recognized during the Annual PDCA Roundtable in Atlanta in February 2003. The award will be in the name of the PDCA member directly involved with the project.

Project Qualifications
Any project that uses driven piles is eligible for the PDCA Driven Pile Project of the Year Award, including but not limited to those that use piles to solve deep foundation problems, earth or water retention situations or anchorage problems. Projects may be marine-based or land-based and may involve any installation technique. Projects will be judged on qualities such as uniqueness, timeliness, unusual aspects of pile driving or unusual solutions to foundation problems, value engineering or value to the public or the industry.

Eligibility
To be considered for the PDCA Driven Pile Project of the Year Award, projects must involve driven piles and at least one participant who was a PDCA contractor, technical affiliate or associate member during the year. Projects may have commenced before the year 2002 and may be incomplete at the end of the year as long as the pile driving portion of the project was completed in 2001 or 2002.

Judging
A jury consisting of the members of the PDCA Public Relations Committee will select the winning project.

Entry Requirements
All nominations must be submitted on the official entry form with accompanying photographs and a written description of the project. Entry forms are available from PDCA headquarters, the chairman of the Public Relations Committee or the PDCA Web site. The winner will be expected to make a presentation that includes photographs or slides at PDCA's Winter Roundtable in February 2003. The written description should explain the project's design concept, highlight any problems where piles provided a solution and point out economic considerations or innovative solutions or techniques employed in the project.

Nominations
There is no entry fee. To nominate a project, submit the completed entry form, available on the PDCA Web site, from PDCA headquarters or from the chairman of the Public Relations Committee, with photographs or slides and the written description to:

Steven K. Whitty Jr.
Public Relations Chairman
c/o Specialty Piling Systems, Inc.
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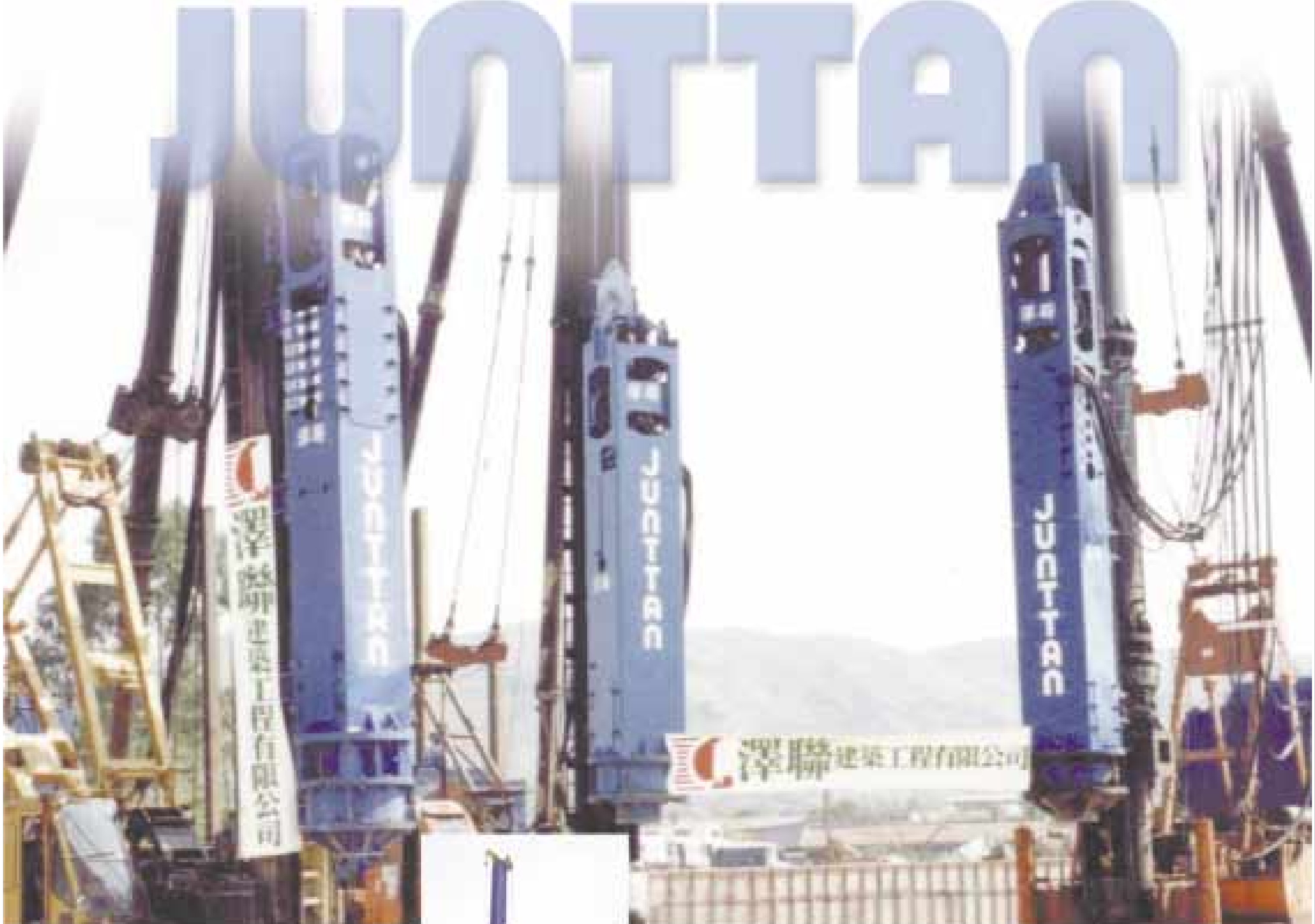
All information requested on the entry form must be provided, and entries must be received by Dec. 1, 2002.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VROOM

PDCA Seeks Nominations For Annual Driven Pile Project Of The Year Award

Last year's winning project was BP Exploration, Inc.'s Northstar Island.

By Jennifer Hart, Editor

Have you been involved in a driven pile project that was new, innovative or just plain exciting? Perhaps your company manufactured, installed or designed driven piles or a driven pile foundation that really impressed the project's customer or contractor. Or maybe you have a project where your company overcame countless obstacles to ensure the safe and timely installation of a foundation. If so, the Pile Driving Contractors Association wants to hear about it.

The PDCA is soliciting nominees for its 2002 Driven Pile Project of the Year. The recognition program, initiated last year, provides a way to honor PDCA members who have contributed to the industry in the form of a noteworthy project where driven piles were used to solve foundation problems. The winning project and contributor will be presented an award at the PDCA 2003 Winter Roundtable in Atlanta, which begins Feb. 21, 2003.

Last year's winning project, BP Exploration (Alaska), Inc.'s Northstar Island, was submitted by engineering firm and PDCA member Peratrovich, Nottingham & Drage, Inc. of Anchorage, Alaska. The project involved a man-made 4.5-acre gravel island more than six miles off the shore of Alaska's Northern Slope. This oil drilling and production island was the first of its kind in the United States. PN&D's winning entry included descriptions of the harsh Alaska conditions and unique engineering challenges of this project. The success of the project was founded in the unique design and installation of driven piles, both in sheet piles and as other support members. The entry was accompanied by several pictures and supporting documentation to further illustrate the scope and magnitude of the project.

Alan Christopherson, PE, senior vice president, had this to say about winning the 2001 Driven Pile Project of the Year:

"...We also like working with contractors and try to see things from their perspective whenever possible. We were extremely honored to be presented with the Driven Pile Project for the Year Award from a contractor's group like the PDCA ..."

To qualify for nomination, the project must involve only driven piles, as opposed to drilled options and the pile-driving portion of the project must have been completed in 2001 or 2002. At least one project participant must have been a PDCA member –

(Continued On Page 14)

Driven Pile Award

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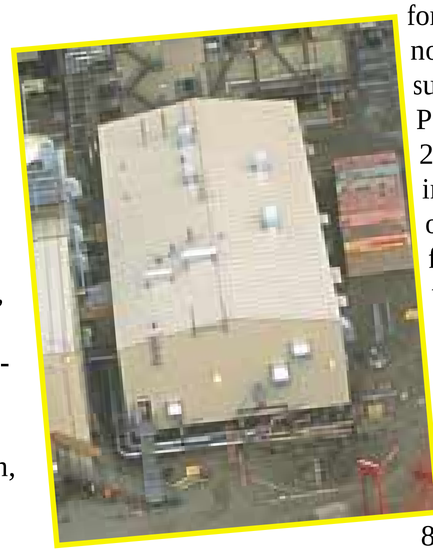
contractor, technical affiliate or associate – during the time of the project's installation. Projects may include but are not limited to piles used to solve deep foundation support problems, earth or water retention situations or anchorage issues. A nominated project could be marine or land-based and may include other installation techniques, as long as pile driving was one of the techniques.

A panel of PDCA members chosen by the PDCA Public Relations Committee will select the winning project based on qualities such as uniqueness, timeliness, unusual aspects of pile driving, unusual solutions to foundation problems, value engineering or value to the public or industry. The project need not meet all of these qualities but should contain at least some of them.

Entry Requirements

Nomination forms should include photographs or slides and a typewritten description of the project. The written description should explain the unique qualities of the project, especially as they pertain to driven piles. It should also provide some detail of the design concept, explain any problems where piles provided a solution, economic considerations and innovation solutions or techniques employed in the project. The winner will be expected to make a short presentation of the winning project at the PDCA Winter Roundtable.



There is no fee to nominate a project for this award. All nominations must be submitted to the PDCA by Dec. 1, 2002. For more information, to obtain an entry form and copy of the rules or to submit a project, contact: Project of the Year Competition, PDCA, P.O. Box 1429, Glenwood Springs, Colo. 81602. Telephone and e-mail requests for applications can be directed to the PDCA office at (888) 440-7453 or info@piledrivers.org.

Successful Professors' Institute Paves Way For More Pile Driving Education

By Jennifer Hart, Editor

This summer, 27 engineering professors from colleges and universities across the country met at beautiful Utah State University in Logan, Utah, for the first-ever College Professors' Piling Institute. This intensive five-day seminar was strategically planned to educate and energize the engineering community about driven piles for deep foundations.

Instituting The Institute

The College Professor's Piling Institute has been dubbed by PDCA President Jim Frazier as "one of the most important things the PDCA has done to date." After hearing about the preparation, participation and feedback from the individuals involved in the Institute, it is easy to mirror Frazier's sentiment. George Goble, principal of George G. Goble Consulting Engineer, LLC, of Boulder, Colo., and other PDCA members felt strongly that it was time to begin an educational effort on the use of driven piles.

Goble, an engineering professor for 30 years and adjunct professor at Utah State, saw the need for university students to understand driven pile design and the changes in technology that have taken place over time.

In addition to his years as a professor, Goble has developed several instruments used in driven pile foundation design, and he conducts six to eight continuing education courses each year. From his experience in these areas, Goble, together with Professor Joe Caliendo of the Civil and Environmental Engineering Department at Utah State, created a curriculum to update professors on new development and design techniques for driven piles.

"We needed something to show our technology being put into practice," said Goble.

PDCA's Education Committee members decided to host two dozen professors for an annual education week and provide them with materials that could be used in their classrooms. Since the Utah State faculty was interested in hosting the event at their beautiful campus in Logan, the first annual College Professors' Piling Institute was born.

Field Demonstrations A Hit

Goble and PDCA Executive Director Stan Orr, CAE, decided on a program and agenda *(Continued On Page 17)*

Professors' Piling Institute Receives Rave Reviews

"Thank you (Joe) and the PDCA very much for organizing and underwriting the professors' workshop last week at Logan. It was first class all the way, and it will be very helpful to me in getting more up-to-date driven pile material into my courses. Best wishes with future courses."
-Michael W. O'Neill, PhD, PE, Cullen Distinguished Professor of Civil Engineering, University of Houston

"I just wanted to thank you (Joe), Loren, George and Stan again for doing a fabulous job last week. It was a very good experience and a lot of fun, as well. As I reflected on the week on my trip home, I was amazed at how much we covered. The field work was great, and I learned a lot of new things about dynamic analyses. Bill and I spent the flight home trying to figure out how to get all this new material into our curriculum."
-Chris Baxter, University of Rhode Island

"Great job on the workshop. We here at UMR do a lot of these, and we couldn't have done any better. I look forward to working with you on other projects."
– Richard Stephenson, University of Missouri

"Thank you for giving me the opportunity to attend the PDCA course. I have benefited a lot. The course was done professionally and superbly. Again thank you all."
– Professor M. Sherif Aggour, Director of Geotechnical Group, Civil Engineering Department, University of Maryland

Professors' Piling Institute Faculty

Name	University/Company
Loren R. Anderson	Utah State University
James A. Bay	Utah State University
Dan Brown	Auburn University
Joseph A. Caliendo	Utah State University
George Goble	George G. Goble Consulting & Engineering, LLC
Pat Hannigan	GRL Associates, Inc.
Mike McVay	University of Florida
Frank Rausche	GRL Associates, Inc.

and interested professors were asked to submit an application to be considered for the Institute. All expenses, excluding personal travel expenses, were paid by the PDCA. According to Goble, responses came in from all over the country.

"We were very pleased at the cross section of respondents we received to attend the Institute," Goble said. "We were hoping to have 25 professors and we accepted a few extra, in case we had some professors who could not make it. Twenty-seven professors attended."

The professors spent four days in the classroom and two half days in the field for demonstrations. Classroom work focused on the geotechnical aspects of the design of the driven pile. Goble noted that many professors were taking notes on the material that was presented.

"We distributed a manual with copies of all the lectures to the professors," Goble explained. "Many professors said these materials, along with their notes, would be helpful in working driven pile design into their curriculums."

The field demonstrations, the highlight of the Institute, and were well-received by the professors. PDCA-member Build, Inc., of Bountiful, Utah, supplied the equipment and crew to drive piles for the demonstration and PDCA-member Nucor provided the steel piles. Caliendo, faculty coordinator for the Institute, commented on the cooperation of these companies.

"Fred Stromness and Build, Inc. put an enormous amount of time and resources into making the outdoor demonstrations a success. There was a lot of time and money tied up in equipment and materials for the field work, and the suppliers were very gracious and generous with their resources," he commented.

A short distance from Utah State's campus, steel piles were driven one morning and then statically load-tested to failure the next morning. In addition, two energy measurements were taken – a dynamic measurement on the driven pile to predict capacity and surface wave measurements. All testing was sponsored and performed by GRL Associates, with help and coordination from Utah State and faculty members Ken Jewkes and Dr. Jim Bay.

"I was very impressed with the enthusiasm of all the professors, and I was encouraged to see some of the leading deep foundation researchers in attendance," said Goble. "I think Utah State, and in particular Loren Anderson, head of the Engineering Department, and Joe Caliendo, did an incredible job of organizing and hosting this event. I look forward to continuing the education process with them in the future."

Questionnaires distributed at the close of the Institute yielded much positive feedback. Many professors commented that they attended the conference to improve their curriculum and were interested in classroom materials on driven pile foundations. The informal discussions were valuable, and the PDCA plans to allow more time for such discussions at the next Institute.

"We hope to continue the Institute for the next four years, educating a total of 125 professors – ideally at least one from each university," said Frazier. "Our only stumbling block to achieving this goal is financing. We had many generous sponsors this year, and Utah State was a gracious and generous host, but the PDCA still needs your help *(Continued On Page 18)*

Professors' Piling Institute Sponsors

Company	Contact	Level
Build, Inc.	Fred Stromness	Platinum
Piling, Inc.	Randy Dietel	Platinum
L.B. Foster	Don Vukmonic	Platinum
TXI	David Usery	Platinum
Nucor	Mike Engstrom	Platinum
Skyline Steel	Rory Kelly	Platinum
Junttan Oy	Markus Nymark	Gold
Lawrence Construction	Rick Lawrence	Gold
Gulf Foundation	David Watkins	Gold
Foundation Constructors	Chris Luthen	Gold
GRL	Frank Rausche	Silver
Pile Dynamics	Garland Likins	Silver
Berminghammer	Patrick Bermingham	Silver
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Harper Structures	John Isola	Silver
Geokon	Jim Gregor	Silver
H.B. Fleming	John Linscott	Silver
Link-Belt	Pat Collins	Silver

Institute

(Continued From Page 17)

to continue this education process in the future. Please begin thinking about a small contribution to next year's Institute. I assure you that any sponsorship is a good investment in the future of our industry."

He continued: "I would like to thank Utah State, Loren Anderson and the engineering faculty for lending us their beautiful campus for our Institute. The reception, food and activities were top-notch. I felt the surroundings definitely enhanced the learning experience. Also, our Institute's own knowledgeable teachers, Dr. George Goble, Dr. Frank Rausche and Pat Hannigan from GRL, Professor Dan Brown from Auburn University and Professor Mike McVay from the University of Florida, along with Professors Joe Caliendo and Loren Anderson of Utah State, were a critical part of this successful program."

Since the completion of the Institute, CDs with materials and pictures have been sent to the professors who attended, and each participant has been added to a mailing list for future information updates.

For more information on how you can contribute to the Second Annual College Professors' Piling Institute, scheduled to be held next summer, contact the PDCA at (888) 440-7453.

Professors' Piling Institute Participants

Name	University
M. Sherif Aggour	University of Maryland
Khalid Alshibli	Louisiana State University
Chris Baxter	University of Rhode Island
John Bowders	University of Missouri
Paul Cosentino	Florida Tech
Lewis Edgers	Tufts University
Sarah Gassman	University of South Carolina
Andy Graettinger	University of Alabama
Jim Hanson	Lawrence Technical University
Andrew Heydinger	University of Toledo
William H. Highter	University of Massachusetts
Priyantha W. Jayawickrama	Texas Tech University
Raj P. Khera	New Jersey Institute of Technology
William D. Kovacs	University of Rhode Island
Fred Kulhawy	Cornell University
James Long	University of Illinois
Scott Merry	University of Arizona
Saheil Nazarian	University of Texas at El Paso
Michael W. O'Neill	University of Houston
Phillip Ooi	University of Hawaii
Robert L. Parsons	University of Kansas
Anand J. Puppala	University of Texas at Arlington
Kyle Rollins	Brigham Young University
Richard Stephenson	University of Missouri - Rolla
Hani Titi	University of Wisconsin - Milwaukee
Joseph Wartman	Drexel University
Thomas Zimmie	Rensselaer Polytechnic Institute

Seventh Annual Winter Roundtable Focuses On Pile Driving Challenges

By Jennifer Hart, Editor

The Pile Driving Contractors Association's Seventh Annual Winter Roundtable will address issues that affect the pile driver every day with seminars presented by leading engineers, professors and contractors in the deep foundation industry.

The Roundtable is scheduled for Feb. 21 through Feb. 22, 2003, in Atlanta.

The tone of the Roundtable will be set immediately by its opening session, titled "Driven Piles: Educating Owners and Neighborhoods on Capacity, Noise and Vibrations." Led by Dr. Frank Rausche of GRL Associates of Cleveland, the seminar will address some of the hot buttons that challenge pile drivers on bid day and on the job. Issues of cost savings and speed will also be covered during this session.

The remaining sessions will be equally pertinent, with topics such as the quality of driven piles, conducting effective field test programs, vibration monitoring, noise suppression and a roundtable discussion on noise and vibration. The Woodrow Wilson Bridge project will be spotlighted as a case study for the monitoring and control of noise and vibration.

Another Roundtable highlight will be the presentation of the Driven Pile Project of the Year Award for 2002. A representative from the winning project will make a short presentation during the conference.

In addition to educational opportunities, the Winter Roundtable will provide an exhibition featuring suppliers from all aspects of the driven pile industry, giving participants the opportunity to see the latest technology in equipment and other pile driving products and services, visit with the suppliers and manufacturers and ask questions about how these products and services can improve their operations.

Contractors, engineers, geotechs, suppliers and engineering students can benefit from the education and networking possibilities available at the Roundtable. The Conference will be held at the Sheraton Buckhead Hotel. The room rate is $149, and the Roundtable registration fee is $295 for members of PDCA, $325 for non-members and $195 for spouses.

For updated Roundtable information, contact the PDCA at (970) 384-1231 or visit the Association's Web site at www.piledrivers.org.

Seventh Annual PDCA Winter Roundtable

Proposed Schedule of Sessions

7 a.m.-8 a.m.	Continental Breakfast
8 a.m. - 9:15 a.m.	Opening Session: Driven Piles: Educating Owners and Neighborhoods on Capacity, Noise and Vibrations • Frank Rausche
9:15 a.m. - 10 a.m.	Quality of Driven Piles vs. Augered Piles • Chris Thompson
10 a.m. - 10:20 a.m.	Break
10:20 a.m. - 11:20 a.m.	Roundtable discussion: The Quality of Driven Piles • Panel
11:20 a.m. - Noon	Conducting Effective Field Test Programs • Wayne Waters
Noon - 1:30 p.m.	Project of the Year Award
1:30 p.m. - 2:15 p.m.	Vibrations: A Perception Issue • Jim Bay
2:15 p.m. - 3 p.m.	Effective Vibration Monitoring
3 p.m. - 3:30 p.m.	Break
3:30 p.m. - 4:30 p.m.	Noise Suppression Equipment for Hammers • Geert Jonker
4:30 - 5:30 p.m.	Noise and Vibration Monitoring at Woodrow Wilson Bridge
5:30 p.m. - 7 p.m.	President's Reception

7 a.m. - 8 a.m.	Continental Breakfast
8 a.m. - 9 a.m.	Cost Savings in Driven Piles • Bermingham Construction Equipment
9 a.m. - 9:45 a.m.	Rapid Construction
9:45 a.m. - 10 a.m.	Break
10 a.m. - 10:30 a.m.	Inspector's Course • Peter Osburn
10:30 a.m. - 11:45 a.m.	Roundtable Discussion on Noise andVibration • John Linscott, Reggie Lee, Others
11:45 a.m. - Noon	7th Annual Membership Meeting

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Proven Success For Driven Pile Foundations

By K.R. Bell, J.R. Davie, J.L. Clemente and G. Likens

This article first appeared in "Deep Foundations 2002: An International Perspective on Theory, Design, Construction, and Performance," Proceedings of the International Deep Foundations Congress, February 2002, sponsored by the Geo-Institute of the American Society of Civil Engineers. Geotechnical Special Publication No. 116. Reston, Va.: ASCE, 2002, pp. 1029-1037.

Abstract

Over the past several years, a seven-step process has been developed for selecting driving criteria that has proven to be a successful formula for the installation of driven piles. The process incorporates static pile capacity estimates, wave equation analyses, pile driving analyzer use and static load testing in a rational and consistent sequence and has resulted in reliable and cost-effective driving criteria. The process has been used successfully for relatively small projects but most frequently on projects that include 100 to several thousand piles. Experience with this process on many projects has resulted in a 100 percent success rate in static load testing, with measured factors of safety between 2.5 and 3.0, avoiding excessive conservatism in design and unnecessary cost.

Introduction

The need for deep foundations on any project typically results from many factors, including subsurface conditions, foundation loads and allowable foundation settlement criteria. Once a decision is made to use deep foundations – in particular, driven piles – the next step is the selection of the type of pile to be used and the design of the pile. Selection of the pile type, in addition to local experience and practice, is frequently based on subsurface conditions, while the preliminary choice of pile size and length is usually determined by static pile capacity calculations. The next decision is how the pile should be driven, including the selection of the pile driving system and the driving criteria. Accurate selection of the driving criteria will not only affect the reliability of the pile foundation but can also greatly affect the overall cost of installation of the piles.

Many methods are available to determine the appropriate driving criteria. This paper discusses a process that has proven successful, resulting in reliable foundation design. We should note that the majority of the projects included in the paper are power plants with costs ranging from $300 million to more than $500 million. Hopefully, we will demonstrate that the process discussed here is valid and useful not only on projects of this size but also for moderately small projects where driven piles are used for foundation support.

Pile Driving Criterion

In its simplest form, a pile-driving criterion is defined as a specified pile-driving resistance when the driving operation can be stopped. The criterion in the United States is generally expressed in a minimum number of blows per foot or blows per inch. In other parts of the world the criterion is expressed in SI units, typically as a minimum number of blows per 250 mm or 300 mm. Less commonly, the driving criterion is expressed as less than a defined movement for a specified number of blows. The desired result is to establish a mechanism that ensures a driven pile will have adequate capacity with a reasonable factor of safety.

Understating the driving criterion can result in a pile with less than adequate capacity. Overstating the driving criterion can mean that the pile will be unnecessarily driven to a higher resistance and depth, generally resulting in additional cost to the project and impact on schedule. Overdriving can also result in damage to the pile. Selection of the right criterion helps to achieve a successful project in terms of both safety and cost.

The Process

There are different methods available for the selection of a pile-driving criterion, including dynamic pile-driving formulae, wave equation analyses and evaluation of static and dynamic load tests. Any of these methods, if used properly, can result in the determination of a valid driving criterion. Although the process outlined here contains no new tools or unique methods, it details a method to simply link and combine several established tools to optimize the final driving criterion selected. The steps of the process are:

1. Evaluate subsurface data and perform static pile capacity analysis.
2. Select preliminary driving criterion using wave equation analysis.
3. Drive probe (or indicator) piles across the site area using a pile driving analyzer (PDA) to evaluate capacity, driving stresses and hammer performance, including retapping of selected piles after initial setup.
4. Evaluate and adjust the driving criterion based on the results of the PDA.
5. Drive static test pile(s) using the revised driving criterion.
6. Load test the test pile(s).
7. Perform a final evaluation of the driving criterion for the production piles based on the load test results.

A detailed discussion *(Continued On Page 22)*

Proven Success

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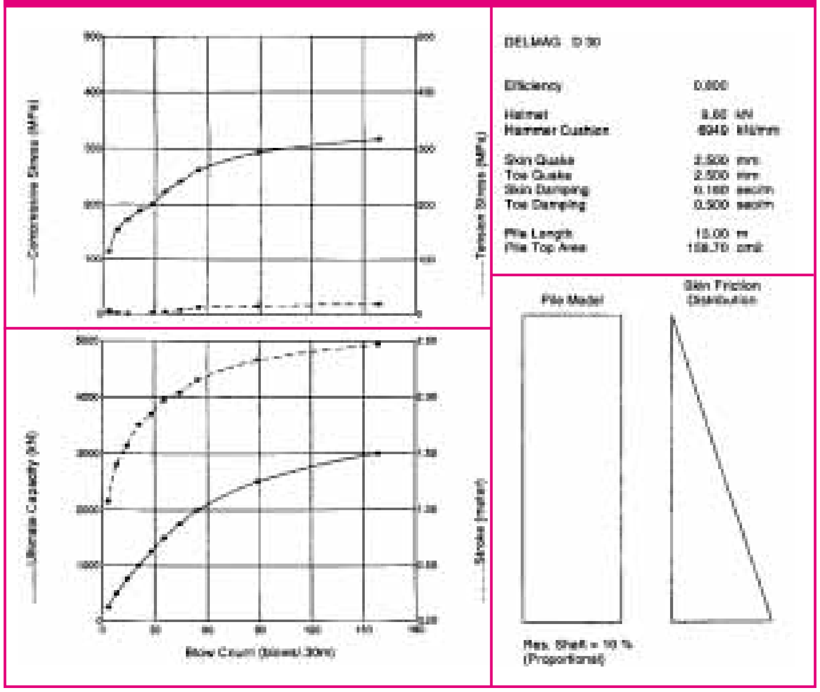
of each step is included below.

Evaluate subsurface data and perform static pile capacity analysis. It is essential to have adequate subsurface data, regardless of the type of foundation or ground improvement to be used. Without having a reasonable subsurface investigation with a sufficient number of exploration points, along with an adequate laboratory testing program, the remaining steps in this process are greatly compromised.

Once the subsurface data are available, the engineering study for the project is started. The decision to use piles typically results from having soft/loose soil conditions near the surface that would result in unacceptable settlement or inadequate bearing capacity for shallow foundations. The next step is to perform a static pile capacity analysis. Before we can proceed with this, we need to have some idea of the pile loading, not only in compression but also in tension and lateral loading, to select the type and size, or range of types and sizes, of pile to be analyzed. Obviously, the loading per pile will depend on the number of piles selected per foundation. For driven piles for major power plant foundations, we have found that compressive capacities in the 750 to 1,200 kN range result in economies in pile cap design. This typically defines the driven pile size – normally in the 300 to 400 mm diameter range for these loads. The type of pile selected is governed mainly by cost and availability, as well as local practice. However, the loads can also influence this selection process – displacement piles will provide more skin friction and thus accommodate larger uplift loading, while piles with high bending stiffness values (elastic modulus times moment of inertia) provide larger lateral resistance. The static analysis often determines that several types of pile will be acceptable for a given project, such as precast concrete, pipe piles, shell piles or H-pile sections.

There are numerous methods for performing static pile capacity analysis, using either hand calculations or available computer software. The static analysis is the starting point in the procedure and is rarely used as the final determination of the pile capacity for a project. In many cases pile capacity estimates based on static analysis are conducted and issued as preliminary calculations until the entire design procedure can be completed. It is still important to provide as accurate an evaluation as possible at this point because the static analysis usually forms the basis for the cost estimate and later bidding of the piling for a project. In addition, the static analysis and resulting cost estimate are often used for comparison with other alternatives, such as some method of ground improvement, to determine if piling is the most economical solution.

Figure 1
Typical Wave Equation Printout



The static analysis provides an estimate of ultimate pile capacity. Factors of safety are applied to obtain allowable or design capacity. Safety factors of 2 on skin friction and 3 on end bearing are commonly used. It is also equally important to ensure the design will perform within acceptable levels of settlement. This is typically as far as we would proceed with a pile foundation design during the estimating stage of a project.

Select preliminary driving criteria and hammer energy from wave equation analysis. If the project bid is successful, the next step would be to issue a pile bid package. As indicated above, there may be a single pile type or numerous pile types included in the bid package, often with the option for the contractor to provide an alternative type. In addition to including the pile parameters (dimension, capacity and estimated length) in the bid package, a range of the required driving energy for the pile hammer is typically provided. This is done to ensure that the contractor has the right equipment available to do the work. To estimate this driving energy, a preliminary wave equation analysis is performed. At this time, since the actual details of the piles and pile driving systems are unknown, it is necessary to make some assumptions in performing this preliminary analysis. These include details of the hammer and driving system (driving helmets, pile cushions, pile efficiency, etc.).

One of the goals of the preliminary wave equation analysis is to find the right range of driving energy to make sure that the pile is not damaged during driving (oversized hammer) or that the total driving time needed to achieve the required capacity is not unreasonable, and that the required capacity can actually be achieved (undersized hammer). The wave equation analysis provides an estimate of pile stress during driving. For steel piles, only compressive stresses need be evaluated, while both compressive and tension stresses need to be checked for concrete piles. Part of this process also includes selecting a factor of safety for the required ultimate capacity (Rult) obtained from the wave equation analysis based on the pile design allowable loading. We commonly apply a factor of safety to Rult of between 2 and 2.5. We typically repeat these steps in the process for each type of pile included in the bid package and for

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Proven Success

(Continued From Page 22)

several types and models of pile hammer. Again, it is important to note that everything to this stage has been classified as "preliminary" since sufficient information is still not available to make the final design selection.

As indicated, the results of the static analysis and initial wave equation analysis are used in the bid package for the piling contract. After the bidding is completed and a contractor has been selected, we can determine the actual driving system that will be used for the project. The selected contractor is requested to supply the details of his available driving equipment, including details of the hammer, hammer system and pile driving cushion(s) proposed for the project. It is important that, once the decision is made to use a particular hammer for a given project, changing the hammer should not be allowed except under extreme circumstances. As will be discussed in more detail below, even replacing the hammer with the same model during production can be undesirable. With the data provided by the contractor, the initial wave equation analysis is modified to incorporate the actual equipment that will be used, and the preliminary driving criterion for the project is established. Again, during this process it is necessary to select an appropriate factor of safety, typically in the range of 2 to 2.5, and to verify the driving stresses are within acceptable ranges.

Figure 1 shows the standard printout from a wave equation program, in this case for a project using steel H-piles and a Delmag D30 diesel hammer. We have a pile with a design capacity of 1,000 kN and a corresponding Rult of 2,500 kN using a 2.5 factor of safety. Based on these results, a preliminary driving criterion of about 89 blows per 300 mm would be selected for this project. It is important at this stage to check that the selected driving criterion is not in the flat or horizontal portion of the curve, because at that point little additional capacity can be achieved and time and money will be wasted driving the pile beyond that point on the curve. It is also common practice to require that the driving criterion be met for up to three consecutive increments of 300 mm to make sure that the pile is well seated in the bearing layer, especially when driving a pile to a refusal condition. Driving criteria can also include minimum tip elevations when piles are being designed to carry tension and lateral loads in addition to axial compression loads. The printout also shows the stresses that are expected to be developed in the pile during driving. These results must be checked to verify the pile will not be overstressed during driving.

At this time we have a pile contractor, pile type and preliminary driving criteria selected and are now ready to start the actual work.

Drive probe piles. Up to this point, the work has been limited to desktop studies in the office. It is now time to move to the site. At this stage, for a large piling project, we would select 10 to 20 locations across the site to drive probe (or indicator) piles. Driving probe piles has several goals, including determining how the piles actually drive on the site as compared to the predictions of the preliminary analyses, especially since subsurface conditions almost inevitably vary, and to evaluate the driving system being supplied by the pile driving contractor. The probe piles can be either production piles or preproduction piles not used for production. Use as production piles can save money but requires that the foundation design be far enough along to accurately define pile placement and that there is a high degree of confidence that the probe piles will have sufficient capacity based on the subsequent pile load testing.

The first goal at this time is to verify that the pile driving criteria can be achieved with the pile driving equipment and the selected pile and, perhaps most importantly, using the length of pile estimated from the original static calculations and thus maintaining the estimated cost. The probe piles can also be used as a good indicator of the range of pile lengths that will be required for all the production piles. This is particularly important if precast concrete piles are to be used for the project.

A second goal of the probe pile program is to allow verification of the pile driving system being supplied by the contractor. This is typically done using a pile driving analyzer during driving of some or all of the probe piles. By using the PDA, accurate estimates can be made of the driving energy going into the pile and the actual driving stresses in the pile, and a more precise evaluation of the ultimate pile capacity can be achieved. The estimate of the driving energy going into the pile is very significant since the efficiency of any pile hammer varies considerably. This variation in efficiency depends not only on the make and model of the hammer, which are known parameters, but, equally importantly, on the maintenance of the hammer. We have found the efficiency of hammers to vary from as high as 85 percent to as low as 33 percent. If we are unaware that a hammer is operating at very low efficiency, the subsequent test piles could be driven with entirely inadequate criteria, quite possibly resulting in a failing pile load test. This failing test would have to be repeated, causing time delays to the project and additional costs.

We also recommend that PDA be repeated on several of the probe piles as part of a retap program to determine if either pile setup (freeze) is occurring or some relaxation has resulted with time. Although it is usually best to wait about a week before conducting a retap program, it is more typical to wait only two to three days or even less, since pile driving is almost always controlled by schedule. Being able to measure pile freeze is particularly important when driving piles that will develop capacity in skin friction in cohesive soils, where much of the initial pile driving resistance has been lost due to pore pressure buildup and shear failure from the driving. It is also important not to allow final cutoff of the probe piles until the final driving criteria are established, in case it becomes necessary to redrive these piles.

Evaluate and adjust the driving criteria based on the PDA. In a perfect world, the results of the PDA would precisely match the initial static calculations and wave equation analysis. Since we do not live in a perfect world, it is important at this time that the results of the PDA testing be evaluated against the preliminary analyses. The

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Proven Success

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purpose of this verification is to determine if adjustments are necessary to the driving criteria to be used for the next stage of the project, namely driving the test piles. During this stage of the process, the Rult determined from the wave equation analysis and the PDA should be compared to see if similar results are being obtained. We have typically found that if the Rult from the PDA is less than that predicted from the wave equation analysis, the actual pile hammer efficiency is less than that originally assumed. Once the pile hammer efficiency adjustment is made to the wave equation analysis, close agreement generally can be achieved between the two.

When analyzing the PDA results for capacity, the data are usually evaluated by CAPWAP, a signal matching process that extracts the resistance distribution and soil behavior such as damping and stiffness from the measurement. The soil model can be used to improve the refined wave equation analysis results. CAPWAP can provide a simulated static load test as an important and useful element of the analysis. Upon completion of the review of all available data, adjusted driving criteria can be determined and used with a high degree of confidence in the next stage of the process – driving the test piles.

Drive test piles for static load testing. Many will argue that using static load testing in addition to running PDA is overkill in the process, but, at this time, at least for large piling projects, we always conduct static load testing in addition to PDA testing. (On many projects we will reduce the number of static load tests in conjunction with the PDA. However, static load tests are still required by many building codes.) The test piles are driven at various locations across the site using the adjusted driving criteria. We also typically monitor the test pile driving using PDA to confirm the pile driving system characteristics and the predicted Rult against the pile capacity that will be measured from the static load test.

Static load testing. The static axial compressive load testing on each project is performed in general accordance with ASTM D 1143 (ASTM) using either the standard or the quick load test procedure. The load testing is typically conducted to three times the allowable design loading or to failure, whichever occurs first. (Typical code requirements are to load the pile to twice the design load.) Once the load testing, which typically includes a minimum of two to three piles, is completed, the results are evaluated to determine the ultimate pile capacity. There are many methods available in the literature to estimate the ultimate pile capacity from the load test results. The allowable capacity is then determined by applying a factor of safety to this ultimate capacity. The Standard Guidelines for the Design and Installation of Pile Foundations, 20-96, by the American Society of Civil Engineers (ASCE) provides recommendations for factors of safety that are dependent on the level of site investigations and testing, as shown in Table 1. As can be seen from Table 1, if the entire process as outlined in this paper is followed, the lowest factors of safety recommended by Manual 20-96 can be applied to the design.

Table 1
Partial Safety Factors F_1

Capacity Determination Method	Design Axial Loads			
	<133 kN (<15 Tons)	142-356 kN (16-40 Tons)	364-889 kN (41-100 Tons)	>889 kN (>100 Tons)
From Pile Load Test Coupled With Wave Equation And Static Analysis	1.5	1.5	1.6	1.8
From Dynamic Measurements Coupled With Wave Equation And Static Analysis	1.5	1.6	1.7	2.0
From Wave Equation And Statis Analysis	1.5	1.8	1.9	N/A
From Driving Formulas And/Or Static Analysis Or Other Method	1.5	2.0	N/A	N/A

Perform final evaluation of driving criteria for production piles. The results of the static load testing are compared with the results of the static analysis, the wave equation analysis and the PDA. If good agreement exists between all of these, the driving criteria established for the test piles are then adopted for use for all production piles and production driving can be started.

If the static load test results do not agree with the analyses, then the option is to adjust the driving criteria either upward or downward. The driving criteria will be adjusted upward if the load test showed less capacity than required and may be adjusted downward if the load test showed more capacity. Adjusting the driving criteria at this point is always a concern, since it is difficult from a cost and schedule standpoint to perform additional load testing on piles driven to the adjusted criteria. Slight adjustments can easily be justified and verified by additional wave equation analysis. If the load test results prove to be significantly different from the results of the wave equation analysis and PDA, it may be necessary to restart the process.

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Proven Success

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For numerous projects over the past decade or more, we have never found it necessary to restart the process.

Additional Notes

Unfortunately the process does not always stop at this point. Despite the best efforts and a carefully thought out and well-planned design procedure, things can change during production driving that will cause havoc with the driving criteria. The two most common problems are unanticipated variations in subsurface conditions and changes in the characteristics of the pile driving system. Piles driven short can occur as a result of changes in the subsurface conditions or densification of the soils from the pile driving, especially piles driven with close spacing in granular soils. If piles are being driven short, additional PDA can be conducted to evaluate their capacity. Based on the results of the PDA, the piles can be accepted unless the minimum tip elevations required for tension or lateral capacities have not been obtained. A problem with shorter than anticipated prestressed precast concrete piles is that cutoff can leave insufficient reinforcement for lateral capacity. If soil conditions are poorer than expected at planned tip elevation, the piles will drive longer than anticipated. This can be a particular problem for piles that are difficult to splice, notably prestressed precast concrete piles.

The other major problem that can occur during production driving is a change in the characteristics of the pile driving system. This may result from reusing pile cushions for too many piles, especially plywood cushions for precast concrete piles, or simply from wear and tear from the continuous operation of the hammer. It is a fact of life that pile hammers are mechanical pieces of equipment whose characteristics change with use. Hopefully these changes are minor during a given project and do not affect the driving criteria over the period of driving. Things to watch for are fairly obvious, such as a change of the hammer during production driving or even maintenance of the hammer. Change of hammer should not be allowed during a project unless it is unavoidable. The hammer should not be changed simply to suit the contractor's workload or schedule. Even if the replacement hammer is of the same make and model, the driving energy can be significantly different. PDA can be justified on larger piling jobs to qualify additional hammers.

The simple maintenance of a hammer can also change the driving energy appreciably. As an example, on a project in Egypt, the contractor replaced the compression rings in the open-ended diesel hammer during the down time for load testing and prior to production driving. This maintenance to the hammer more than doubled the driving energy to the pile. This change, if not detected by PDA, would have caused all of the piles to be significantly overdriven. On a more recent job in Taiwan, the PDA during the probe pile installation indicated that the variable stroke hydraulic hammer was only operating at about 33 percent efficiency. The piling contractor contacted the hammer manufacturer, who suggested a series of maintenance items that should be conducted on the hammer. However, since driving the probe and test piles had been completed, and sufficient energy could be achieved by using a higher stroke setting, it was decided not to allow the contractor to perform the maintenance until after all the production piles were driven.

Even if no changes are made in equipment or no maintenance is performed, changes to the characteristics of the hammer can occur that cannot be detected visibly but can significantly affect the energy transfer to the pile. The best method for evaluating these potential changes during production driving is to conduct additional PDA testing. It is our general policy to allow for about 5 percent of the production piles to be tested using PDA. If required, adjustments in the driving criteria can be made at this point.

Summary And Conclusions

As stated earlier, there are no new techniques presented in this paper on how to have a successful driven pile project. However, we hope that some benefit can be gained from summarizing the various established steps as a single coherent process. Many would argue that on smaller projects the process outlined above would be cost prohibitive and too time consuming. Obviously this is true where only a handful of piles are needed. However, the process is applicable to moderately small projects, particularly where the piles are spread over a relatively extensive area.

We have had considerable success with this process and, fortunately, have not experienced a pile project where there has been a pile failure or settlement of a structure beyond levels anticipated. The process has been and can be applied to any type of driven pile (precast concrete, steel pipe, steel H-pile and shell piles). In addition, by using all or even some of the steps in the process, a high level of confidence in the results can be obtained, allowing for the use of lower factors of safety. This will reduce the overall cost of the piling and the overall time required for installing the piles, which can quickly and easily outweigh the cost of following this process. In conclusion and, most importantly, sound, experienced engineering knowledge and judgment must be applied to every step of this process to ensure success.

References

• *American Society of Civil Engineers. (1996). Standard Guidelines for the Design and Installation of Pile Foundations. 20-96.*
• *American Society of Testing and Materials. (2001). Standard Specifications Volume 04.08.*

For additional information, visit the ASCE Web site at www.pubs.asce.org.

PDCA Membership Application

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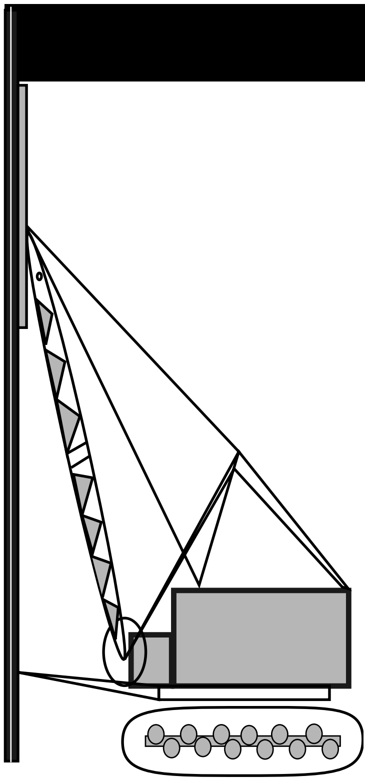

Primary or Official Representative

Company: ____

Name: ____

Title: ____

Phone: ____

Fax: ____

Address: ____

City/state/zip: ____

E-mail: ____

Home page: ____

Membership Type

(check one)

- ❑ Contractor
- ❑ Associate
- ❑ Technical Affiliate
- ❑ Student

Sponsored By: ______________________________

Contractor Company Description

(check all that apply)

- ❑ Pile Driving
- ❑ Marine Contracting
- ❑ Earth Retention
- ❑ Bridge Building
- ❑ Deep Dynamic Compaction
- ❑ Bulkheads
- ❑ Other ______________

Associate Company

(check all that apply)

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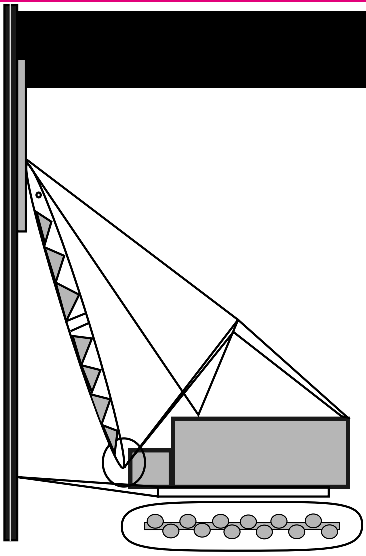
- ❑ Sales
- ❑ Vibratory Drivers/Extractors
- ❑ Steel Beams
- ❑ Pipe Pile
- ❑ Timber Pile
- ❑ Concrete Pile
- ❑ Cranes
- ❑ Fixed/Swinging Leads
- ❑ Steel Sheet Piling
- ❑ H Bearing Piling
- ❑ Pile Point & Splicer
- ❑ Jet Pumps
- ❑ Plastic Pipe Piles
- ❑ Inserts
- ❑ Steel Fabrication
- ❑ Wick Installation Equipment
- ❑ Sheet Piles
- ❑ Drills
- ❑ De-Watering Pumps
- ❑ Composite Pile
- ❑ Cushion Materials
- ❑ Pile Driving Leads
- ❑ Wick Drain
- ❑ Cutter Head
- ❑ Drill Bits
- ❑ H-Beam
- ❑ Plastic Sheet Piles
- ❑ Drive Caps
- ❑ Dock Supplies
- ❑ Off Shore Leader System
- ❑ Wick Drain Supplies
- ❑ Drilling Supplies

Pile Hammers

- ❑ Vibratory
- ❑ Diesel
- ❑ Hydraulic
- ❑ Air/Steam

- ❑ Other__________________
- ❑ Other__________________
- ❑ Other__________________
- ❑ Other__________________

PDCA Membership Application



Technical Affiliate Company Description

(check all that apply)

- ❑ Analysis
- ❑ Design
- ❑ Testing
- ❑ Vibration Monitoring
- ❑ Surveys:
- Description ____________________
- ❑ Consulting
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- ❑ Technical Affiliate - $75 per person
- ❑ Student - $25 per person

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Card Number: ______________________________ Name on Card: ______________________________________

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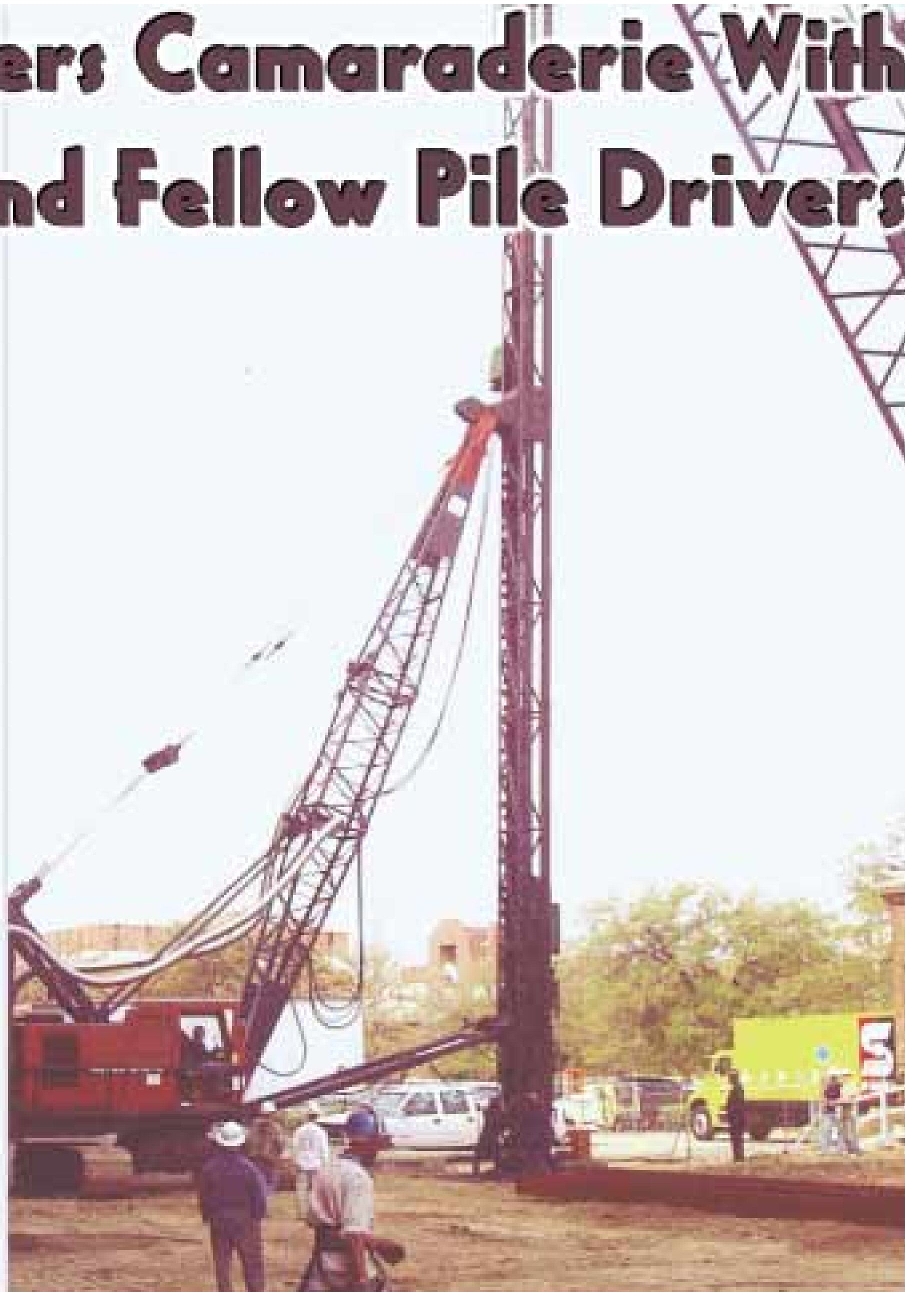
S.C. Firm Fosters Camaraderie With Contractors And Fellow Pile Drivers



By Jennifer Hart, Editor

In Charleston, S.C., estimator John King has a saying: "You can pay us [pile drivers] now or later, but eventually everything will be on piles."

Although King is half joking when he says this, he is also quite serious. According to King, Charleston is known for its muddy soils, and driven piles comprise a large percentage of deep foundations in the area. King hopes that number will be near 100 percent in the not-too-distant future.

"In my experience, other types of deep foundations cannot withstand the test of time," said King. "And with standards established by the International Building Code 2000, auger cast foundations may not be feasible for the Charleston area if they need to be reinforced to the tip."

King should know. He has been working for Pile Drivers, Inc., in Hollywood, S.C., for 12 years. A small family business, King's duties have branched beyond those of estimator. He is often called upon to oversee jobs, cut cushions, run material or perform any other duties needed to complete the project on time and satisfy the customer.

MUSC Children's Research Institute

Recently, Pile Drivers, Inc. has been involved in driving piles for a large expansion project at the Medical University of South Carolina. MUSC is upgrading some of its research and clinical laboratories to better serve the South Carolina market. Pile Drivers, Inc. worked as a subcontractor on two projects with pre-existing foundations: the Children's Research Institute and the Hollings Cancer Center. In both instances, MUSC demolished three-story buildings to erect seven-story buildings. Pile Drivers, Inc. overcame some interesting challenges on both projects.

The Children's Institute was a small project that required more than 250 steel H-piles, 12" x 53# sections with 110 foot lengths. Piles were driven using an ICE 640 hammer. King thought the biggest obstacle the team would have to face was the tight working space, but, unfortunately, he was mistaken.

"This project finished behind schedule due in large part to the discovery of a graveyard on the building site," explained King. "Apparently, the previous building had been built near an old pauper's graveyard. The pile driving crew uncovered several bodies. After each discovery, the crew would stop, a ceremony would be held and then the individual would be reburied in a different location. Construction continued but it was slow going."

King was right in assuming that there would be challenges based on the tight working space. The research facilities on MUSC's campus are in close proximity to one another. The project was halted on more than one occasion because diesel fumes (non-hammer related) were coming through the air intake of a nearby facility. The pile project was eventually completed, but it was almost two years behind schedule, mainly because of design delays.

MUSC Hollings Cancer Center

Working for the same general contractor but under a different contract, Pile Drivers, Inc. began installation of more than 500 steel H-piles (12" x 53#) for the expansion of the MUSC Hollings Cancer Center this June. The piles were driven using an ICE 640 hammer because the double-acting hammer drove quicker than the single-acting hammer used in a previous phase of this project. The first section was 60 feet, then a 50-foot section was spliced onto the pile. The project was scheduled to be completed in August, but the discovery of gas lines has delayed

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Pile Drivers Unite In Coastal Carolina

Pile Drivers, Inc. is one of several pile driving companies in the Charleston area. John King is friendly with his competitors and said they work well with each other. The only real competition is on bid day. A representative from one of the other active pile driving companies in the area, Palmetto Pile Driving, Inc. of Charleston, felt

that it was time to pool together industry resources to market pile driving services through the initiation of a local PDCA chapter, a first for the Association.

"Collectively, we need to make the pie larger. One way I see for doing that is to sell our services to local owners and designers in our area," said Harry Robbins of Palmetto Pile Driving. "Aligning ourselves with a national organization like the PDCA lends us credibility and resources while giving the Association a grass-roots effort on educating the public."

Robbins decided to pursue a local affiliation with the PDCA after reviewing the state of the pile driving industry in coastal South Carolina last spring. He noticed that companies that sell alternative foundation systems are doing a much better job of promoting their products than pile drivers. Despite the widespread use of driven piles in the residential market, alternative systems are making inroads into commercial and industrial construction.

After discussing his idea with PDCA Executive Director Stan Orr, CAE, Robbins organized a meeting in Charleston at the end of May with Orr, PDCA Board member Wayne Waters, King and seven other pile driving professionals. The first order of business was to create a steering committee, of which Robbins is the chair, and discuss plans for the local chapter's bylaws. Orr has provided Robbins with bylaws that the chapter could use as a model, and they are currently being reviewed.

"As a local chapter, I envision us using national publications, research and education seminars to help us achieve our objective of maximizing the use of driven piles in South Carolina. In addition, we expect to address issues that are specific to our local area," said Robbins. "Such issues as the effect of the International Building Code on driven piles and how to deal with vibration concerns in historic Charleston are important topics for our pile drivers."

He continued: "The bottom line is we can be certain that someone is telling owners and design professionals that pile driving is noisy, creates vibrations and costs too much. We need to join together to make certain that decision-makers have accurate information about the best deep foundation system – driven piles."

Robbins, King and other pile driving professionals hope to hold education seminars, create printed materials and improve the public perception of pile driving through a sustained public relations campaign. For more information on how to initiate a local PDCA chapter in your area, contact PDCA's national headquarters at (888) 440-7453.

S.C. Firm

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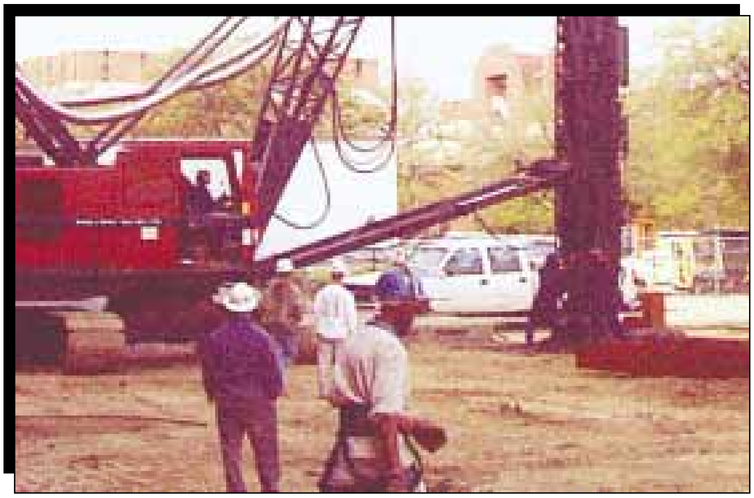
completion. Piles for both of these projects were furnished by PDCA-member Skyline Steel.

King said this project was uneventful until the discovery of the gas lines, yet it was typical of many of his company's pile driving projects.

"We are a reliable pile driver that moves in and gets a job done. General contractors can count on us, and that is why they have a certain comfort level working with us. I am always proud of our pile driving efforts when we are rolling along," he said.

Interestingly, MUSC is going to great lengths to keep the public informed about its building expansions. The state of South Carolina tracks progress on all its projects by setting up an on-site camera. The college included video from the camera on its interactive Web site to show an up-to-the-minute picture of the construction work. King said he can log onto MUSC's Web site and monitor his crew's activities.

Since the delay of completion of the pile installation for the MUSC Hollings Cancer Center, Pile Drivers, Inc. has been recruited for another project at the university. A team will begin work shortly on an addition to a building that will require 72 steel H-piles, 121 feet long with 12" x 53# sections. Again, the steel piles for this foundation are being supplied by Skyline Steel.



Pile Drivers, Inc. was started in 1972 by George and Louise Geiger. Mr. Geiger, an experienced bridge-builder, had only one crew when his company began driving piles for houses. Today, Pile Drivers, Inc. is still run by Louise Geiger, her daughter and nephew and it operates three crews that drive wood, concrete and steel H-piles for commercial, industrial and residential projects near the South Carolina coast. The company is known as one of the most versatile pile drivers in the area because of the owner's willingness to drive one pile or thousands of piles – whatever it takes to get the job done.

King commented that Pile Drivers, Inc. is often called upon for residential work and many times operates without a contract. He said the projects agreed upon with a handshake seem to be much less trouble than those under contract. And he notes that the company has never had to write off a project that didn't include a contract. That's the kind of trusting relationship the company has with many general contractors in the area.

The opening session of The Pile Driving Contractors Association's Seventh Annual Winter Roundtable will highlight the challenges pile drivers face on bid day and on the job. But that's only the beginning. The rest of the two-day program will delve into a variety of topics critical to the success of pile driving contractors, engineers, geotechs and suppliers.

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