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PILEDRIVER

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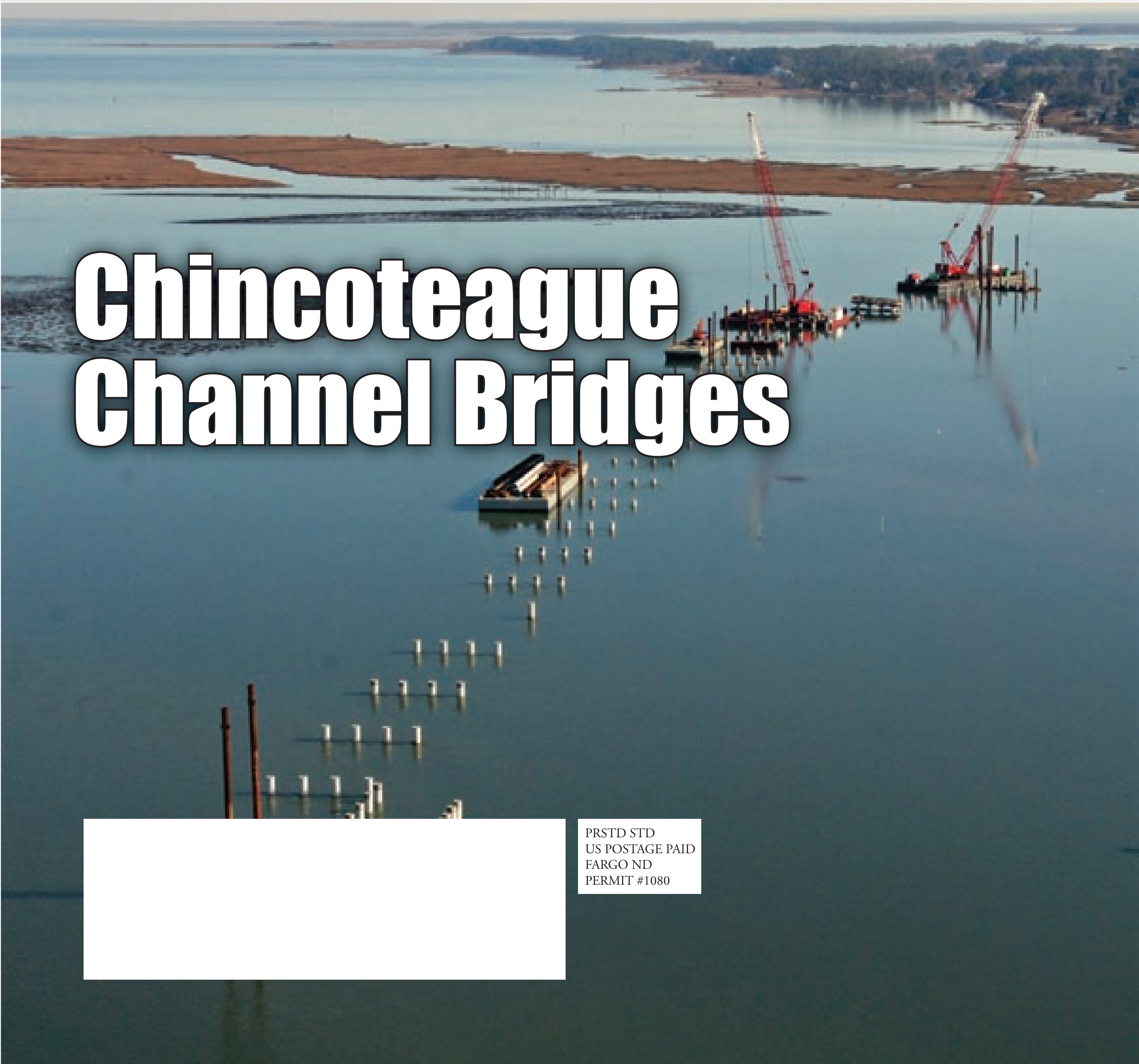

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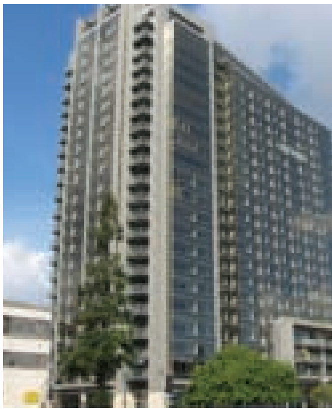

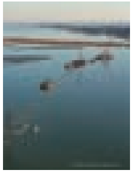

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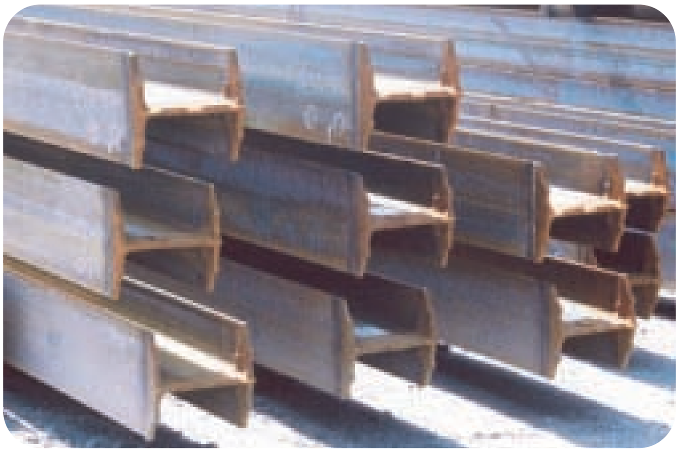

Time flies when you are having fun!

By Van Hogan

The PDCA had a good year in 2008. We got off to a flying start with our Annual Meeting held in Phoenix, Ariz. Over 200 members attended the event last February. They enjoyed presentations, met with exhibitors, networked, played golf and enjoyed an outstanding dinner and casino night.

After the Annual Meeting we got back to work. To better serve members, the PDCA moved into its new office in Orange Park, Fla. and hired Marian Phillips as an administrative assistant.

Preparations began in earnest for the upcoming International Foundation Congress and Equipment Exposition 2009 in Orlando, Fla., which will serve as the location of the Annual Meeting this year.

The PDCA worked with the Geo-Institute of ASCE and ADSC, our partner organizations, to finalize details, procure sponsors and make final preparations for the conference. Mike Justason, chair of our Education Committee, worked diligently to promote and procure technical papers pertaining to driven pile installation and testing for presentation at the conference. The process of preparation, peer review and acceptance of each paper was quite lengthy so there was no time to waste. Over 30 papers on some aspect of driven piles will be presented at the upcoming conference to an audience estimated at over 2,500 attendees.

Mike Justason and his committee also coordinated with Mike Elliott, chair of our Market Development Committee, to develop and present our first webinar this year. The webinar was facilitated by the FHWA and was very well received. The topic of the webinar was New Technologies in Driven Pile Equipment. It provided great information on the technological improvements within our industry and the new tools we are developing to deal with the challenges we face. We hope this will be the first of many webinars. We currently have another webinar being developed for the Geo-Institute of ASCE, which should be ready for presentation early next year. The webinar is a great educational tool that allows us to reach a worldwide audience to present useful information on the benefits of driven piles.

The Technical Committee led by Dale Biggers has made good progress in its meetings with AASHTO's T-15 committee. The Technical Committee has been working diligently to update Sections 10.5 and 10.7 of the driven pile design code. This process is very detailed and specific. AASHTO's T-15 committee takes its responsibilities very seriously. Any proposed changes to the current code must be reasonable, thoroughly explained and justified before they will be considered for adoption. The Technical Committee has spent untold hours of preparation, discussion and review in an effort to update the code. The intent of its efforts is to provide a more level playing field with alternative deep foundation systems so that driven piles can be fairly assessed during the design phase of a project.

The Market Development Committee led by Mike Elliott began making preparations for our 2010 Annual Meeting in Coeur d'Alene, Idaho. Identifying venues well in advance gives our association much more flexibility in negotiations and more time to prepare for what will be a great and memorable event. From all reports, Coeur d'Alene is a beautiful location with wonderful facilities for our Annual Meeting.

In November, we conducted our hurricane-delayed DICEP in New Orleans, La. It was a great success. Attendance was good, the presentations were well received and there were a number of exhibitors on hand to provide information on their products. The Gulf Coast Chapter did an outstanding job in promoting this conference and making it a success.

Just prior to the DICEP Conference the Strategic Planning Committee met to develop a plan that will guide the PDCA for the next three to five years. We have come a long way since our inception and we want to maintain that growth in the years to come. As we continue to grow, our collective voice and our ability to promote driven piles will grow as well. A special thanks to immediate past president Mark Weisz for his leadership in organizing this effort.

We also welcomed four new committee chairs this year: Joe Savarese became chair of the Environmental Committee, Pollyanna Cunningham became chair of the Communications Committee, John Lanigan became chair of the Safety Committee and Don Dolly assumed the chair of the Membership Development and Member Retention Committee. We wish all of them much success in their new positions.


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On the horizon, we have the IFCEE '09 conference coming up March 15 to 19, 2009. In cooperation with our partners, the ADSC and the Geo-Institute of ASCE, we expect over 2,500 attendees at a conference that will encompass the presentation of over 250 technical papers, panel discussions and short courses. In addition, there will be a large area for indoor exhibits and a larger area for outdoor exhibits featuring the latest equipment from numerous manufacturers from around the world.

This will also serve as our Annual Meeting and is an event you cannot afford to miss. The event is being held at the Buena Vista Palace at Walt Disneyworld, so there will be plenty of activities for the entire family. Please make plans to attend.

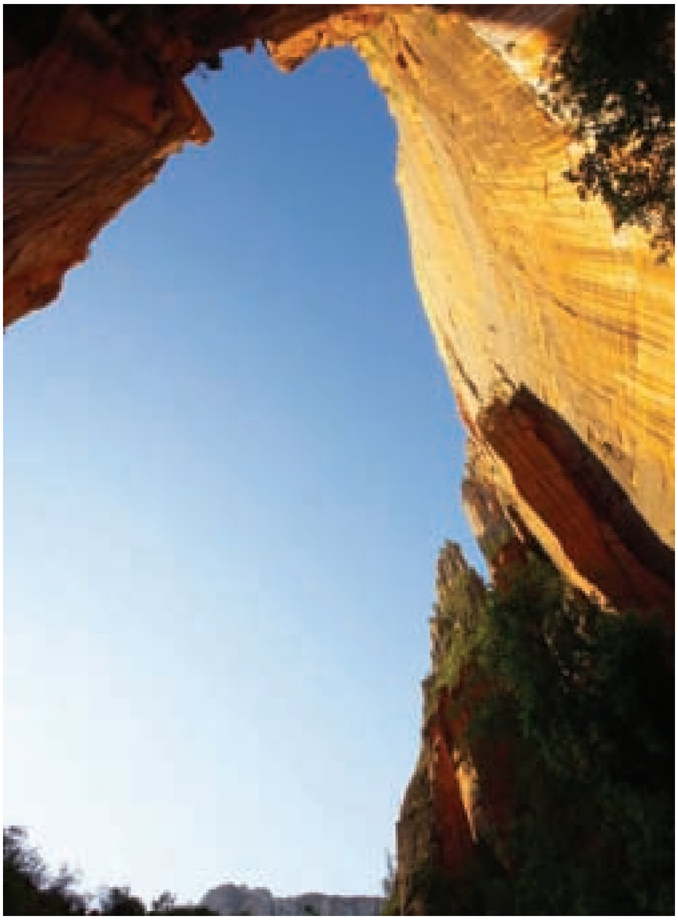
Also on the horizon will be our 5th Professors' Driven Pile Institute (PDPI). This event will be held at the campus of Utah State University in Logan, Utah from June 14 to 20. The PDPI provides education on the subject of driven piles, which includes hand-on experience, to approximately 25 college professors. We are investigating the possibility of expanding the class to include a few design engineers as well. This course is one of the most cost-effective programs we sponsor. We often hear from professors in the program that they never received this type of instruction regarding driven piles, but after they attend this week of intensive study, each professor will not only have received this training but will also be able to pass on the information to his or her students. Future engineers will have a working knowledge and familiarity of driven piles by the time they graduate. Planning for this year's program is well under way and we look forward to hosting this event. There is not a finer venue in the country.

Playing a critical role in the success of everything mentioned thus far is our executive director, Steve Hall. Steve continues to grow with and enhance our organization with his dedication and expertise. Steve has made it a point to visit each chapter during the course of the year and has represented the PDCA at a number of industry conferences. Marian Phillips has been a welcome addition to our staff and has allowed us to provide more in the way of member services.

The most critical role in our success, however, has been filled by you – our members. The Pile Driving Contractors Association can accomplish nothing without your support and involvement. You make it all possible. This organization exists because we can accomplish more collectively than we can accomplish individually. Please continue to support it to the best of your ability and make your voice heard. Your investment will be repaid many times over.

In closing, it has been a pleasure and a privilege to serve as your president this past year. I want to thank the members of the board of directors, the committee chairs and members and the PDCA staff for their dedication and the hours they have invested to make this organization successful. I also look forward to the leadership to be provided by our incoming president, John King, and wish him well.

The economic outlook for 2009 might not be as rosy as in past years but, as they say, "This too shall pass." When it does, we'll be ready. In the meantime, let's take advantage of every opportunity we can and keep driving because A Driven Pile Is A Tested Pile. ▼



Together we will stand

By Stevan A. Hall

While writing this message on the day of the 56th presidential inauguration, I took a quiet moment to contemplate what 2009 holds for the United States and what we as an industry can expect as a result of new policies that will certainly be established by our Congress and the 44th President of the United States, Barack Obama.

Are Barack Obama and Joe Biden the change we need? Can they affect a new, more positive direction for the U.S.? Can they turn around a down economy? Or, will Obama's presidency translate into four years of failed policy, over spending, higher taxes, and a Congress that is more intent on getting re-elected than serving the true needs of America and its citizens? Only time will tell. One thing is unmistakable: we are at a pivotal moment in U.S. presidential history and whether you voted for Obama and Biden or not, they now represent the new leadership of the country.

For the future of our businesses and our industry, we must hope they succeed, so America can succeed. Succeed or fail, fundamental political and philosophical differences exist between democrats and republicans; liberals and conservatives; and therefore, the PDCA must remain vigilant in our oversight of national policy and legislation.

We must be involved at all levels to the highest extent possible to assure our interests are not diminished and our businesses and industry have the opportunity to be successful and prosper. It is not an easy task to simply monitor what Washington is doing, much less affect the outcome of a legislative bill or administrative policy. One advantage the PDCA has is now incorporated into our new Mission Statement – "Provide a forum for pile drivers to speak with one voice."

Our strength is in our unity as an association; our opportunities lie within that strength.

"Alone we can do so little; together we can do so much" -Helen Keller.

Another portion of our new Mission Statement is, "Be the association of choice for Pile Driving Contractors and those associated with the Pile Driving Industry." Perhaps now, more than ever, the pile driving industry needs to rally around the PDCA, so we can be that one voice – one voice that is heard loud and clear; one voice that can make a difference regardless of the obstacles and challenges we face.

In 2008, the PDCA Board of Directors approved new 2009 Vision and Mission Statements and Strategic Plan.

PDCA's new Vision Statement says, "PDCA's vision is to promote driven piles through education and continuous improvement of methods, materials and equipment. Within the Vision Statement, PDCA identified several core values that will guide us in accomplishing our Vision Statement, which include "One for all, all for one", Communications, Cooperation, Honesty, Integrity, Professionalism, Safety, Sharing of knowledge, Skill, Strong work ethic and Members and Human Resources."

PDCA's new Mission Statement says, "PDCA's mission is to promote driven pile and provide exceptional support and services to our members."

To accomplish this, PDCA will "provide a forum for pile drivers to speak with one voice; Provide educational opportunities and technical support to our members; Educate public and private entities as to the benefits of driven pile; Facilitate improvements in material and equipment technology; Represent the pile driving industry before various organizations and governmental agencies; Build relationships and disseminate information through networking opportunities; Be the association of choice for Pile Driving Contractors and those associated with the Pile Driving Industry."

The new Strategic Plan will provide a roadmap for the leadership of the PDCA to follow through 2011 and, perhaps, beyond. The Strategic Plan incorporates four distinct areas of strategic focus. These areas include Membership, Organizational Structure, Financials, and Program Development. Each area of focus has its own Objectives and Strategies. Just a few of the Objectives identified under each of these areas includes increased services and benefits to members, increase member participation and ownership in the PDCA, promote the formation of new PDCA chapters while supporting growth within existing chapters, provide adequate cash assets for programs, broaden educational opportunities for engineers, contractors, and owners, improve market share for driven pile, and advance the PDCA as an association.

The PDCA Board of Directors and the PDCA committee chairs are familiar with the plan and fully support its implementation and success. As with all good strategic plans, this plan will be a living document and at the forefront of sound decision-making and policy implementation. PDCA members are always encouraged to participate at every level within the PDCA. Your support and participation along with the strategic plan will help ensure PDCA's success, promote driven piles and be a tangible, value-added resource for your business.

The PDCA has a road map for the future. But, as important as it is to know where we are going, it is equally important to know where we have been. 2008 was another good year for the PDCA. We accomplished a lot and continue to build upon the successes we have had in the past.

I want to thank Van Hogan, PDCA president for his passion and commitment to the PDCA. As promised in Phoenix, Van "Kept us driving!" throughout 2008 and into 2009. I want to thank the PDCA Board of Directors. They are often asked to make hard decisions, which they do with a great deal of integrity and always with PDCA's interest in mind. Additional thanks goes to the committees and chairs. Thanks to the Technical Committee (Chair, Dale Biggers, Boh Brothers), Market Development Committee (Chair, Mike Elliott, Pile Equipment, Inc.), Education Committee (Chair Mike Justason, Bermingham Foundation Solutions), Environmental Committee (Chair John Linscott, H.B. Fleming), Communications Committee (Chair Van Hogan, Ed Waters and Sons Contracting Co, Inc.), Membership Development and Member Retention Committee (Chair, John King, Pile Drivers, Inc.) and Finance Committee (Chair, John Linscott, H.B. Fleming).

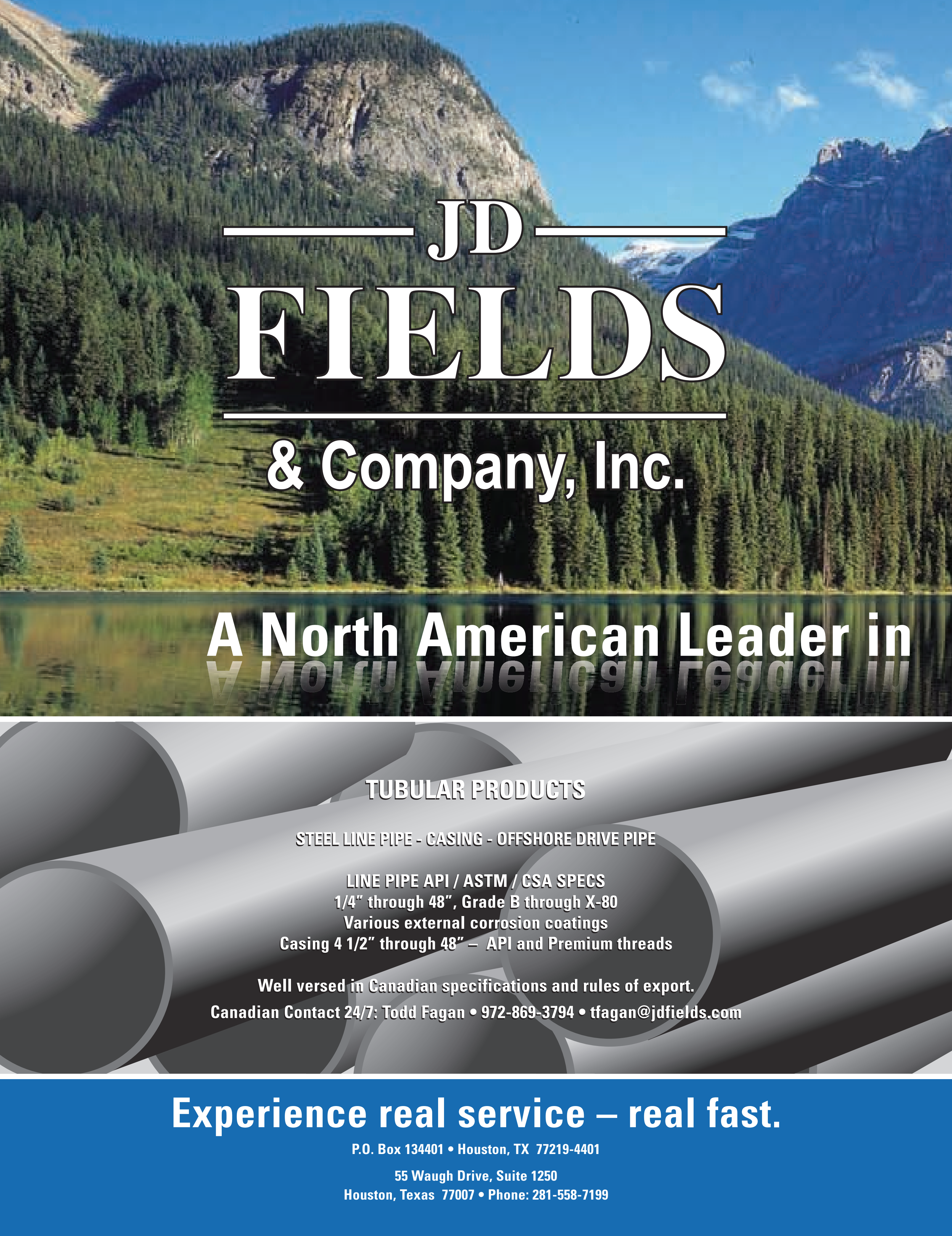
All committees were instrumental in moving the PDCA agenda forward by ensuring visibility, marketability, access to resource and technical information, and a greater market share for the driven pile industry. They are all to be congratulated on their efforts and commitment to making the PDCA a better organization.

Thanks to all of our members. Without your membership, participation and support, the PDCA would not be an organization. This is your organization and you are the reason for its existence. For the past two years, the PDCA has seen phenomenal retention of its existing members. I am optimistic we will see the same in 2009.

With a weak economy, a strong case can be made to owners and developers to incorporate a cost-effective and efficient deep foundation system into their project – that's driven pile.

All things being equal, we are the most cost-efficient product on the market. If you want to view the economy in crisis (and I do not), then through crisis, will come opportunity. The PDCA is a resource to help you create opportunities. We encourage you to support PDCA through your membership. If you were a member in 2008, renew. If you were not a member in 2008, join today.

To paraphrase Theodore Roosevelt: Together we will stand in the arena, our faces may be marred by dust and sweat and blood, but we will know the high achievement of triumph. ▼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MEMBERSHIP BENEFITS

General Membership Information

We are the premier association for pile-driving contractors

The PDCA was founded in 1996 to promote the use of driven-pile solutions in all cases where they are effective. We strive to build and maintain working relationships among end users, manufacturers, government agencies, educational institutions, engineers and others involved in the design, installation and quality control of the driven pile.

We are dedicated to advancing the driven pile

As the only organization solely dedicated to pile-driving contractors, we know that you understand the superiority of the driven pile in most applications. We are the only association addressing the intrusion of non-driven solutions that take away business from the driven-pile contractor. The PDCA understands that to survive in today's competitive marketplace, a pile-driving contractor must strive to stay abreast of the latest trends and technologies in the industry. That is why we maintain close ties with the world's leading suppliers to the industry. It's why we provide a broad range of educational programs for university professors, practicing engineers and contractors. And, it's why more and more contractors, engineers and suppliers are realizing that the PDCA significantly increases their value in the marketplace.

We are a direct link to decision makers

Major manufacturers take an active role supporting the PDCA. At our conferences, we bring together the world's leading design manufacturers and technical application experts to assist you in advancing the driven pile as a superior product.

The PDCA works closely with the technical community to format design codes and installation practices. We offer seminars throughout the country for engineers and educators on the capabilities and advantages of the driven pile. We also work with agencies, such as the Federal Highway Administration and state DOTs, which develop specifications for highway building and other infrastructure projects that use driven piles.

We offer timely, valuable services

The PDCA improves your company's bottom line, as well as your stature in the construction industry, through a variety of programs and services:

Job Referrals

We are the only organization that provides contractor referrals to end users of driven piles. You tell us where you will drive piles and we will refer you to end users. We also provide referrals to our supplier and technical members.

Peer-to-Peer Opportunities

With more than 120 contractor members, the PDCA offers many networking opportunities. Whether at our Annual Conference, DICEP conference, our regional seminars, or by just picking up the phone, you'll develop long-lasting professional relationships and friendships in the industry.

Annual Membership Directory

As a member, you'll receive PDCA's annual membership directory of our contractor, supplier and technical members. Your company is listed along with the piling solutions you employ and states in which you work. This directory is provided throughout the year to construction users on a complimentary basis.

Educational Conferences and Meetings

The PDCA offers cutting-edge education for contractors, engineers, geotechs and anyone else interested in the driven pile and its applications at two major conferences annually. Members receive discounts on exhibit and registration fees.

- The Annual Conference, held in early Spring since 1997, is a nationally recognized conference that brings together leading contractors, technical experts and suppliers to the piling industry.
- The Design and Installation of Cost-Efficient Driven Piles Conference (DICEP), held each September since 2000, is a nationally recognized daylong conference that brings together geotechnical and design engineers, college professors and contractors to discuss the latest trends in understanding, analyzing and controlling piling costs.

Industry Development

The PDCA continually strives to expand market share for the driven pile. The PDCA sponsors the Professors' Driven Pile Institute, held at Utah State University in Logan, Utah. Up to 25 professors from major engineering schools are invited to participate in an intensive, weeklong program that presents them with the latest concepts in driven-pile design, installation and quality control. Some of the leading faculty in the deep foundation field has attended the institute to date. The program supplies the educators with the tools and knowledge to be able to teach their students about the advantages of the driven pile. It promises to have a long-term impact on market share for the driven pile.

Publications and Reference Materials

As a PDCA member, you will receive our quarterly publication, *Piledriver*, which presents articles on issues and trends of interest to our industry. As a member, you'll receive discounts on advertising in the magazine.

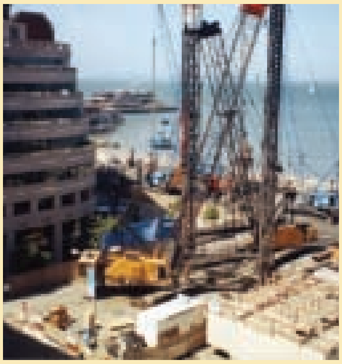
All PDCA members receive a complimentary copy of the PDCA's codebook, *Recommended Design Specifications for Driven Bearing Piles*, now in its third edition. This book covers all required guidelines for driven piles and includes a suggested bid and payment schedule.

PDCA also offers the *Installation Specifications for Driven Pile-PDCA Specification 103-07* as a CD to all new members at no charge.

The PDCA also sells *Driven Pile Foundations, Volume I&II*, an FHWA manual on the design and construction of driven piles.

"Through its programs and services, PDCA has presented our company with numerous opportunities to continue our business success. It is certainly a cornerstone for growth in a very competitive business."

D.R. Jordan, President and CEO, Jordan Pile Driving, Inc.



Connect Worldwide at www.piledrivers.org

The PDCA's newly redesigned Web site at www.piledrivers.org lets you research the latest trends in the industry and find direct links to manufacturers, suppliers, engineers and others. PDCA members receive a free listing in our member search area, which is being used by an increasing number of end users to find pile driving contractors and services. Our forums area makes it easy for you to connect with others to discuss issues and problems.

Leadership Opportunities

Membership in the PDCA provides opportunities for recognition and leadership. Positions are available on the PDCA board of directors and various committees that impact the industry. The PDCA recognizes noteworthy contributions to the industry with our Driven Pile Project of the Year Award, giving opportunities for high profile recognition.

Membership is available to you

There is strength in numbers and we at the PDCA need to count your company when telling government agencies, engineers and suppliers that we are interested in keeping your business viable and in growing market share for the driven pile. We need your ideas and efforts in working together toward a common goal: the use of driven-pile solutions. You can contribute your expertise and assist the Association in developing:

- A greater focus on safety.
- The quality of driven pile products.
- The formatting of codes and specifications for the driven pile.
- Support for a program to help educate students in the use of driven piles.

Join today. Be part of a growing and vibrant organization that will play a key role in the future of deep foundations. Support your industry by completing the membership application in this issue. You will immediately begin to enjoy benefits of membership. ▼

PDCA

MEMBERSHIP APPLICATION

Step 1: Company Information

Company Name: ______________________________

Contact Name: ______________________________

Address: ______________________________

Phone: ____________________ Fax: ____________________

City / State / Zip: ______________________________

Company Home Page: ____________________ E-mail: ____________________

Step 2: Select Membership Type

Important! Read carefully! The PDCA Bylaws define member classifications and qualifications. Dues are established by the PDCA Board of Directors and shown in ( ) for each type.

- ○ **Contractor Member** – General or specialty contractor who commonly installs driven piles for foundations and earth retention systems.
  - ○ Contractor I Member Company – Annual volume > $ 2 million ($850.00)
  - ○ Contractor II Member Company – Annual volume < $ 2 million ($425.00)

- ○ **Associate Member** – Firms engaged in the manufacture and/or supply of equipment, materials, or services to the pile driving industry.
  - ○ Associate I Member Company – Annual volume > $ 2 million ($850.00)
  - ○ Associate II Member Company – Annual volume < $ 2 million ($425.00)
  - ○ Local Associate Member Company ($100.00)
    Small Associate Company desiring membership in a single local chapter, who only serves that local market, and whose interest is to support the local chapter. Membership must be approved by PDCA Executive Committee.

Individual

- ○ **Technical Affiliate Member -** **($100.00)**
  Individual who is involved with the design and installation of driven piles or in teaching the art and science of pile design and installation. May be employed engineers, architects, government or university employees. As a Technical Affiliate, your name and contact information will be displayed in the membership directory as well as on our Web site.

- ○ **Retired Industry Member -** **($100.00)**
  Individual who has reached retirement age, left active employment, and wishes to remain a member.

- ○ **Student Member -** **($20.00)**
  Full-time students studying towards a bachelor, master or doctorate degree in a regular university program.

- ○ **Affiliate Labor Organization Member -** **($100.00)**
  Concerned with pile driving for the purpose of gathering and sharing information.

- ○ **Organization Member -**
  Non-voting membership category. Must be approved by the PDCA Executive Committee.

Step 3: Member Information

(complete only the category for which you are applying)

A. Contractor Members – check all services that your company provides:

- ❒ Bridge Buildings
- ❒ Bulkheads
- ❒ Deep Dynamic Compaction
- ❒ Deep Excavation
- ❒ Docks and Wharves
- ❒ Earth Retention
- ❒ General Contracting
- ❒ Highway and Heavy Civil
- ❒ Marine
- ❒ Pile Driving
- ❒ Other

B. Associate Members – check all products and services that your company provides:

Accessories

- ❒ Cutter Heads and Drill Bits
- ❒ Dock and Marine Supplies
- ❒ Hammer Cushions
- ❒ Other
- ❒ Hoses and Fittings
- ❒ Lubricants and Grease
- ❒ Pile Cushions
- ❒ Pile Points and Splicers
- ❒ Rigging Supplies
- ❒ Safety Equipment

Materials

- ❒ Aluminum Sheet Piles
- ❒ Coatings and Chemicals
- ❒ Concrete Piles
- ❒ Timber Piles/Treated Lumber
- ❒ Composite Piles
- ❒ H-Piles
- ❒ Steel Pipe Piles
- ❒ Other
- ❒ Steel Sheet Piles
- ❒ Structural Steel
- ❒ Synthetic Material Piles

Equipment

- ❒ Air Compressors and Pumps
- ❒ Cranes
- ❒ Drill Equipment
- ❒ Drive Caps and Inserts
- ❒ Hammers
- ❒ Hydraulic Power Packs
- ❒ Leads and Spotters
- ❒ Marine Equipment
- ❒ Specialized Rigs and Equipment

Services

- ❒ Consulting
- ❒ Design
- ❒ Freight Brokerage
- ❒ Analysis
- ❒ Pile Driving Monitoring
- ❒ Geotechnical
- ❒ Marine Drayage
- ❒ Surveying
- ❒ Civil and Design
- ❒ Other
- ❒ Testing
- ❒ Trucking
- ❒ Vibration Monitoring
- ❒ Materials Testing

General

- ❒ Rental
- ❒ Sales

Step 4: Geographic Areas Where Services and Products Are Available

(All applicants check all that apply)

❒ All States	❒ AK	❒ AL	❒ AR	❒ AZ	❒ CA	❒ CO	❒ CT
❒ DC	❒ DE	❒ FL	❒ GA	❒ HI	❒ IA	❒ ID	❒ IL
❒ IN	❒ KS	❒ KY	❒ LA	❒ MA	❒ MD	❒ ME	❒ MI
❒ MN	❒ MO	❒ MS	❒ MT	❒ NC	❒ ND	❒ NE	❒ NH
❒ NJ	❒ NM	❒ NV	❒ NY	❒ OH	❒ OK	❒ OR	❒ PA
❒ RI	❒ SC	❒ SD	❒ TN	❒ TX	❒ UT	❒ VA	❒ VT
❒ WA	❒ WI	❒ WV	❒ WY	❒ Canada	❒ International	❒ Other	

Step 5: Method of Payment

I am providing payment in the amount of:

❒ $850.00 ❒ $425.00 ❒ $100.00 ❒ $20.00

I am making payment in full by:

❒ Check ❒ Visa ❒ MasterCard ❒ American Express ❒ Discover

Card Number: ______________________________ Expiration Date: __________

Name on Card: ______________________________ Security Code: __________

Statement Billing Address ______________________________

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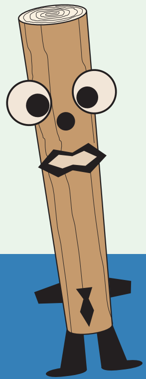


Did You Know?

WHO OR WHAT IS T-15?

In many of the previous PDCA magazines and E-Letters, you have seen a reference to AASHTO's T-15 committee. PDCA has worked collaboratively with T-15 for years, but who or what is T-15?

The American Association of State Highway and Transportation Officials (AASHTO) is the official voice for transportation. Part of the mission of AASHTO is to advocate transportation-related policies and provide technical services to support states in the management of their transportation issues. This includes issues related to construction, which includes issues related to driven piles.

Within AASHTO's organizational structure, there are committees comprised of member department personnel that serve on a voluntary basis. One of these committees is the Standing Committee on Highways. The Standing Committee on Highways is charged, in part, with developing all major engineering standards for the highway program and either as a unit or through its subcommittees, investigate, study, and report on all engineering activities and developments, including all phases of road and bridge design and construction.

Under this standing committee is the Subcommittee on Bridges and Structures.

Hang in there; we are almost to T-15. Under the Subcommittee on Bridges and Structures, are technical committees. T-15, or Technical Committee 15 is Substructures and Retaining Walls. This committee is chaired by Jawdat Siddiqi, Ohio DOT and vice chaired by Tony Allen, Washington State DOT.

T-15 has 11 members from state departments of transportation plus one member representing FHWA. T-15's scope encompasses earth-retaining walls, drilled shafts, and driven pile; they recommend additions or revisions to the design and installation specifications. Once their recommendations are accepted by AASHTO as a whole, these changes become part of the AASHTO code, which gives guidance to the state transportation departments.

PDCA has worked with T-15 for many years and has always appreciated the opportunity for collaboration afforded to us by T-15. ▼

Professor's Driven Pile Institute Returns to USU

PDCA will sponsor the fifth biennial Professor's Driven Pile Institute (PDPI) for Geotechnical faculty from June 14 to 20, 2009 at Utah State University. Full-time faculty members teaching foundation engineering courses are encouraged to apply. All expenses, exclusive of travel to the USU campus, will be paid by the PDCA. Classroom instruction will be carried out on campus in the newly constructed engineering complex at USU. "Students" will stay on campus at the University Inn; and the field events will be held at the USU's nearby test site. The curriculum consists of topics that should be covered in undergraduate and/or graduate-level classes in foundation engineering.

Tentative classroom topics will include:

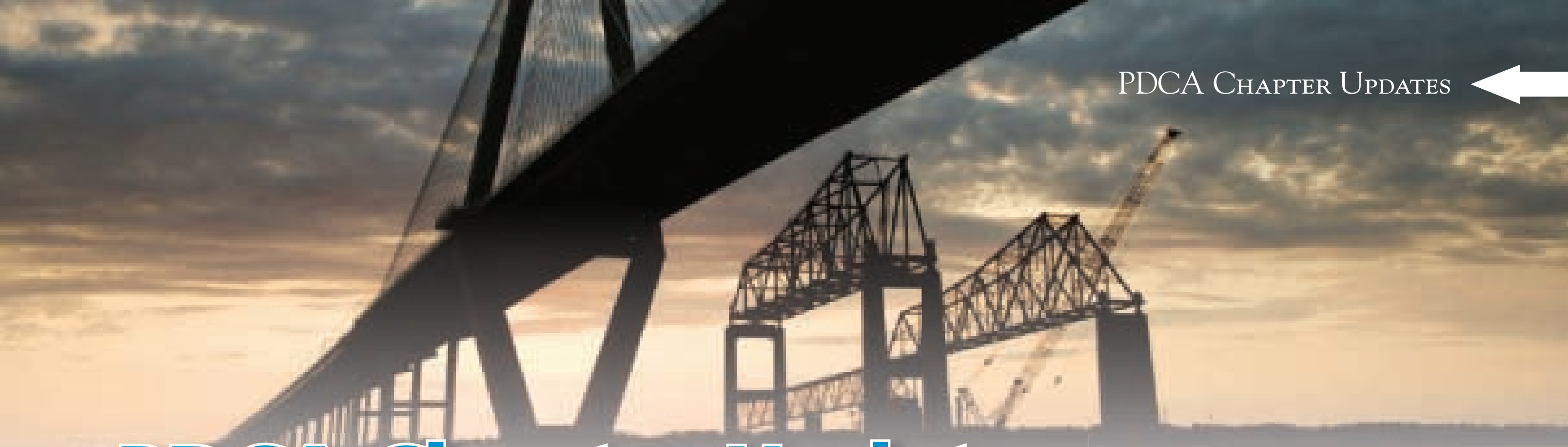
- Static analysis, axial and lateral, or single and pile groups.
- Common pile types and driving equipment.
- Geotechnical considerations.
- Load distributions (t-z, q-w curves).
- Pile driveability.
- Economic analysis.
- Pile dynamics and dynamic testing.

The tentative hands-on computer laboratory sessions will include experience with:

- DRIVEN
- GRLWEAP
- CAPWAP
- LPILE
- FB-PIER

The field portion of the workshop involves driving a test pile and performing a dynamic load testing (PDA) SASW field techniques will be demonstrated. Static axial and lateral load tests will also be performed; and "students" will be involved with the data collection. The field data and classroom presentations will be made available to PDPI participants for subsequent use in your classrooms.

For more information, contact the PDCA offices via e-mail at steve@piledrivers.org or call 904-215-4771 or toll-free within the U.S. at 888-311-PDCA (7322). ▼



PDCA Chapter Updates

PDCA of South Carolina Chapter

PDCA of South Carolina currently has 33 members. The organization meets quarterly for a social/cocktail period, dinner, and to hear a presentation by an industry-related speaker. There are usually 50 to 60 people in attendance, and the chapter tries hard to have the local engineering and academic communities, including the construction industry well represented to continue to voice the message of the chapter, which is the use of driven piles.

The chapter held its third annual oyster roast and barbecue social/networking function on Jan. 30, 2009.

The chapters first quarterly meeting for 2009 will be on March 3, with the program to be determined. All PDCA of South Carolina dinner meetings are held at the Town and Country Inn, 2008 Savannah Hwy, Charleston, S.C. For more information on chapter dinner meetings, contact PDCA President, John Parker, Parker Marine, 843-853-7615.

PDCA of South Carolina is actively promoting the "A Driven Pile is a Tested Pile" ideal and our new mantra "Driven Piles-Recycled, Recyclable and Renewable" acknowledges that our products make for a "green" foundation. With PDCA National's help and an enthusiastic board, PDCA of South Carolina looks forward to a successful 2009.

PDCA of the Gulf Coast Chapter

PDCA of the Gulf Coast Chapter had its first diner meeting on Jan. 29, 2009 at Messina's Restaurant in Kenner. Guest speaker for the evening was PDCA member Henry Whitty (Professional Construction Services) on "Comparative Total Cost of Pile Foundations."

The second quarter 2009 meeting will be held on April 23, 2009, tentatively scheduled at Messina's.

The PDCA of the Gulf Coast Chapter's first annual crawfish boil will take place on April 30, 2009, at the VFW Hall, 3314 Richland Ave., Metairie, La. Time and details will be made available upon confirmation of scheduling.

The third quarter 2009 meeting will be held on Aug. 23, 2009, and the fourth quarter meeting on Nov. 5, 2009. PDCA of the Gulf Coast will also hold officer elections during the fourth quarter meeting. Watch the PDCA Web site for updates on all programs.

PDCA of California Chapter

The California Chapter of the PDCA is working with PDCA National to host the 2009 Design and Installation of Cost-Efficient Piles Conference. This year's conference will be held in the San Francisco area on Nov. 19, 2009. Once the facility and program have been completed, PDCA will announce details of the conference in the conference brochure, Web site and E-Letter.

PDCA of Mid-Atlantic Chapter

The PDCA of the Mid-Atlantic chapter held its first quarter meeting at Paul's On the South River, Riva, Md. on Feb. 12, 2009. Randy Fahs, Hillis and Carnes, was the guest speaker and presented on Inter-County Connector.

Congratulations to Bill Bonneau, Cianbro Corp. and his election as the 2009 President of the PDCA of Mid-Atlantic Chapter. Cianbro is a senior estimator for Cianbro in the company's Baltimore, Md. office. ▼

CIANBRO

There are piling contractors and there are contractors that also drive piling. And then, there are companies that are both of these. For instance, companies like Cianbro.

For Cianbro, driven piling is both a significant source of work on a stand-alone basis and a strategic core competency that competitively enhances its approach to securing projects and supports the ability to control schedules and margins when performing projects requiring driven piles.

Mike Hart, vice president and mid-Atlantic regional manager, said, "We look at the right kind of pile driving project…one with longer and heavier pile, technical challenges or logistical challenges, as a good fit for Cianbro. We look at it [driven piles] as a good piece of business in and of itself. It's a good market for us to be in. It's the same as we look at other types of business like bridges, marine facilities, power plants, dams or water treatment plants. The fact that there is often a good marriage between our pile driving preferences and many of these projects is not an accident."

Cianbro is one of the largest contractors on the East Coast and one of the most diverse, self-performing, merit-shop, general contractors in the U.S. In spite of the growth and market diversity, Cianbro has, over the years, embraced the same critical importance placed on pile driving competencies developed in the company's earliest years of infrastructure construction. Cianbro self-performs across these same markets today, in addition to a wide variety of other markets in which the company has earned a reputation to perform.

The Cianchette brothers started Cianbro in Pittsfield, Maine, and this year marks the 60th anniversary of the company. The company heritage is traced back to the family of immigrants that settled in central Maine and became involved in the construction industry. The Cianchette brothers, first-generation Americans born to hardworking and entrepreneurial parents, started the business after returning from military service overseas where they all served during World War II.

The disciplined work ethic, unquestionable integrity and unfailing family values instilled in their youth would serve them well in their business venture. These same values remain a key part of Cianbro's practices and business culture today even though it is no longer owned by the Cianchette family. Cianbro is now entirely employee-owned, the last of the stock transferred to the employees in 2005 in keeping with the long-term vision of the founding brothers. Also, in keeping with the founder's vision are almost daily reminders of the core values upon which Cianbro was founded.

In every conference room within the company is a plaque that reads: "No One In This Room Is Smarter Than All Of Us," serving as a gentle reminder of the merits of collective wisdom. It's not uncommon to hear the phrase, "Our word is our bond" repeated to reinforce the conviction that upholding commitments is essential to integrity.

The fact that Cianbro retains these values, remains headquartered in Pittsfield, continues to operate as a largely self-performing general contractor – still driving piles and building bridges would seem to mark little change, save for growing to

be a company with over 2,400 team members. But you don't have to look too hard to see how significantly Cianbro has evolved and changed over the years. The 2,400 team members/owners are now spread across three geographical operating regions: Northern New England (Pittsfield); Southern New England (Bloomfield, Conn.) and Mid-Atlantic (Baltimore, Md.) with 30 years of continuous operations already accumulated in these expanded regions.

There are also two steel fabrication facilities (Pittsfield and Baltimore) and three waterfront facilities (Baltimore, Portland, Maine and Brewer, Maine) to support marine, vessel and modular construction projects. More significant than geography, however, is the diversity of the construction markets and projects that define the Cianbro of today.

Primary construction markets for Cianbro include: transportation (with a preference for large bridges; fixed-span or moveable marine crossings); marine construction, power and energy (including hydro), heavy industrial, commercial and institutional, dams, water and waste water and electrical transmission and distribution; marine vessel/off-shore platform construction and large modular construction. Cianbro also operates a steel fabrication and coating business with two steel fabricating facilities, one of which located on the Baltimore industrial waterfront.

The additional Portland and Brewer facilities are also on the water, but their purpose is to support Cianbro's marine vessel/off-shore platform business and the modular construction business, respectively. Modular construction is a relatively new area of business for Cianbro, developed in great part through the efforts of Pete Vigue, president of Cianbro Companies and an area Cianbro is set to grow significantly. The first contract underway is the construction of 52 large refinery modules, weighing between 400 to 1,000 tons each, that will be shipped to Port Arthur, Texas. to become part of the massive Motiva Refinery expansion.

In most of these markets, Cianbro prefers projects that present technical and/or logistical challenges. It's a natural fit.

"You probably won't find us competing on projects with lots of short, small pile with good conditions," said Mike Hart. "You probably will find us competing on projects within our geographies where the piles are longer and heavier or where the conditions or schedule are challenging. We also really like marine construction projects. Whether it's on the water or land, we'll look at the right pile jobs as a stand-alone project. When it comes to larger projects where piling is a component of the overall scope, we'll often look at projects that have a difficult piling piece we can self-perform."

Completed in 2006, Maine's Prospect-Verona Bridge (featured in PILEDRIVER Q2 2007) is a good example of challenging driving conditions. The joint venture Cianbro/Reed & Reed LLC proposed a closely spaced driven pile alternative to drilled shafts socketed 15 feet into bedrock.

The alternative design was eventually worked through and 288 HP14X117 steel H-section piles were driven for each foundation. Driven to 215 ton capacity, more than 20,000 linear feet of pile was successfully driven through difficult

"Driven piling has always been a critical part of the work Cianbro performs and we see no change in the importance of driven piling as a strategic competency and a component of our revenue stream going forward"

- Mike Hart

granular soils containing cobble and boulders and additionally complicated with densification stemming from the tight pile spacing.

In some cases, the challenges stem more from surface conditions as opposed to the geotechnical conditions. A recent project for Magellan Midstream Partners at the terminal in Wilmington, Del., consisted of constructing a marine unloading platform with dolphins and a pipe trestle to land-side, all supported on 16- and 18-inch open pipe pile up to 100 feet in length.

The difficulty was not the pile driving, it was accessing the area to construct the piping trestle which ran several hundred feet over very shallow and muddy tidal flats from the back of the berthing before reaching land. At high tide, the shallow, muddy water provided just enough water to float in and move around if a very shallow draft was maintained on the crane barges; one of which was outfitted with a Manitowoc 4000 150 ton crane and the other a shared, 100 ton service crane.

Conditions like these are often uniquely suited to Cianbro where sectional barges can be configured to provide the necessary draft. Cianbro has one of the largest fleets of sectional barge units outside the U.S. government, and can tackle projects in shallow waters, inland waterways and land-locked bodies of water; the latter is an excellent fit for the dam, reservoir and hydroelectric work Cianbro performs where sectional barges are used for the marine piling and construction scopes. The sectional barges are also put to good use in constructing bridges where they can be appropriately configured to float in massive assemblies such as the 6-million pound center span for the Tomlinson Lift Bridge that Cianbro constructed in New Haven, Conn.

Cianbro has an extensive fleet of equipment that places the company as one of the top 100 construction equipment owners in the U.S.

Piling projects that require a number of cranes from small to large are often well suited to Cianbro with the National Harbor project in Prince George County, Md. being an example (featured in PILEDRIVER Q4 2008). Between the marine and land-side piling work there were four Manitowoc 4100 Series 2 cranes with 230 ton capacities, a single Manitowoc 4000 with 150 ton capacity and a barge-mounted Manitowoc 4100 Series 3 Ringer with 300 ton capacity in addition to other smaller assist equipment.

George Bell, manages Cianbro's Equipment Group, and describes the arsenal of equipment as an inventory totaling over 3,300 pieces of equipment with an aggregate value of over $66 million.

"The workhorses of our crane fleet are primarily Manitowoc," said Bell. "Right now we have four 4100 Series 3 ringers, a number of 4100 Series 2 units along with 4000s, 3900s and so on down the line. We have a sizeable fleet of solid machines and we keep the units pretty busy."

Marine piling projects can be a particular sweet spot for Cianbro. With a good combination of cranes and floating equipment, Cianbro likes marine piling projects whether they are related to a bridge or consist of the construction of marine facilities themselves. When it comes to coffer dams, coffer cells and de-watering, there is deep, seasoned talent to draw from. Enhancing the approach to both marine and land-side piling, Cianbro believes is the innovation that can be applied through a top-notch internal temporary and construction engineering group led by Alan Fisher.

Fisher is well known throughout many circles in the industry as being highly competent, creative and innovative and on more than one occasion, has been consulted by FEMA for his expertise. Most within Cianbro believe this group often provides a strategic advantage in how a project is approached and how risks can be mitigated.

"There are hundreds of projects that we've done over the years where driven piling was a critical component of our work and in many cases, it was the whole job," said Hart. "Driven piling has always been a critical part of the work Cianbro performs and we see no change in the importance of driven piling as a strategic competency and a component of our revenue stream going forward." ▼

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Fax: 757-331-2501
e-mail: Gary.Shrieves@skanska.com

For your Gulf Coast and Mississippi River projects contact:

GULF COAST PRE-STRESS, INC. GCP PASS CHRISTIAN, MISS.

Contact: Max Williams
Phone: 228-452-9486
Fax: 228-452-9495
e-mail: mwilliams@gcprestress.com
Website: www.gcprestress.com

MG Forge Construction Company

By Jim Chliboyko

Gene Merlino has been a football player and fan for most of his life, even playing fullback for his alma mater, U.S. Military Academy West Point. But he probably didn't know his career in pile driving would get him as close to the New York Giants as he recently found himself.

"We were excited to work on all the structures at the Giants's new training facility," said Merlino, from his office in Wayne, N. J. Of course, being on site gave him a preview of the place. He calls it state of the art. Merlino said the piles for the training facility were over 120 feet long, about double the size of those at the new stadium.

"It was a $2.5-million pile package for our share of the stadium, and about a $5-million one for the facility," said Merlino.

Merlino is the 'M' in the MG Forge Construction Company, and he recently found out his company would also be picking up the utility package for the project; that is, the lighting towers and such.

MG Forge also did some work on the newer Meadowlands Stadium, as well, an 80,000-seat stadium, which will house both the New York Jets and the New York Giants when it opens in 2010.

But MG Forge does not discriminate; it accepts work from other sports, too.

"We actually worked on the parking garages at the new Yankee stadium (in The Bronx) and the new Red Bull soccer stadium (the Red Bull Arena in Harrison, N.J.) – some high-profile stuff," said Merlino.

Merlino has worked as a pile driver since 1987, starting his own business in 1994. Most recently, his wife came up with "Forge," which Merlino liked, as it refers to building or producing by hammer. As president of the company, his responsibilities include handling operations, sales and customer relations.

MG Forge does a lot of work on transportation infrastructure, too, such as at the Newark Liberty International Airport and with the New Jersey Department of Transportation. One of the bigger jobs currently involves building new on- and off-ramps for the new interchange at the Garden State Parkway and US Route 78.

Merlino said, being based in New Jersey is ideal for his company. The Garden State has a lot of construction activity, it has a diverse enough economy and there's work to be had in New York, too.

"We do a lot of work for New Jersey Transit, the Port Authority of New York & New Jersey and a lot of housing development up and down the Hudson River," he said. "We do work all the way down from Atlantic City to all (of New York City's) five Boroughs."

Merlino is a new appointee to the PDCA Board of Directors. He put his own name into the hat, largely to represent the northeast.

"I believe in the mission of the PDCA. The whole idea behind the PDCA is promoting the use of piles and being involved in the new techniques, engineering and technology," he said. "It's good to be an active participant in the aims of the organization.

"I like the PDCA. The shared information is a big help, and their whole focus on pile foundations is an important lobby," he said.

Despite all the gloomy economic news lately, Merlino remains positive. While MG Forge's crew can number close to 100, it's currently about half that size. But there is work available and there's also work on the horizon.

"The cycles of construction I've seen, any time a new president is elected, work usually picks up," he said. "We're also looking forward to the part of President Obama's stimulus package that will enhance the areas infrastructure funding. The private sector is slow. We are used to having a number of cranes up and down the Gold Coast [the New Jersey Coast along the Hudson River)."

Ultimately, the man who is in his third decade of foundation work isn't too worried about current economic conditions.

"Revenues are down, but everyone's moving along." ▼

Industry Leaders Gather for Piling College

In November 2008, Cox Industries, Inc. hosted a gathering of piling industry experts in Leland, N.C. This educational event was called the Piling Cox College and invitations were extended to local contractors, engineers and building supply centers. The event was created to increase the interaction between a wide cross section of the industry.

The event was held at Carolina Pole, in frigid temperatures, yet it attracted approximately 35 industry professionals. The attendees were afforded the opportunity to ask questions, network and trade information about all phases of the piling process from the forest to the job site.

Ron Forest, Jr., a professional engineer with S&ME, Inc., stated he found the event extremely valuable.

"As a geotechnical engineer, I am often called upon to specify the piles for a project," said Forest. "The more that I can learn about the properties and capabilities of the products that I am specifying, the more likely I am to make the most cost-effective product recommendation to the owner. It really helped me to see the process of producing timber piles. Previous to this, I had only seen the final product when it showed up on the job site. Also, observing the QC tests that are performed at the plant was very interesting to me, as a consulting engineer. The event gave me a great chance to network with potential clients that were also present at the event, such as the pile installation contractors."

The piling college began with a presentation of Cox Industries's history along with its core values. Several associates from the company were on hand to speak on product inventory, sustainability efforts and quality assurance. Discussions were held about the market confusion over chemical preservatives and the treating process. The group was able to tour a manufacturing facility to watch all aspects of the process, from delivery through peeling, pressure treating and shipping. There were also interactive piling grading demonstrations and contests. Nick Clark, general manager of Augusta Wood Preserving, educated the group on the topics of quality assurance, material certification, pile driving equipment and pile installation.

Among the industry experts taking part in the event was Tony Doster, North Carolina region manager for Resource Management Service, LLC (Wilmington, N.C.) who discussed the SFI (Sustainable Forestry Initiative) program. The presentation was based on the premise that responsible environmental behavior and sound business decisions can coexist. The SFI standard was described as one of the world's most rigorous and widely applied standards of sustainable forestry. It sets forth measures by which interested parties – customers, conservation interests, or members of the public – can monitor and evaluate the commitment of program participants to practice sustainable forestry. Not only are program participants committed to improving the performance of their own operations, they are also setting new standards for the forest industry and extending those practices to other forest landowners, as well.

Doster also presented information on fiber sourcing, product labels and chain of custody approaches. Visit www.sfiprogram.org for more information.

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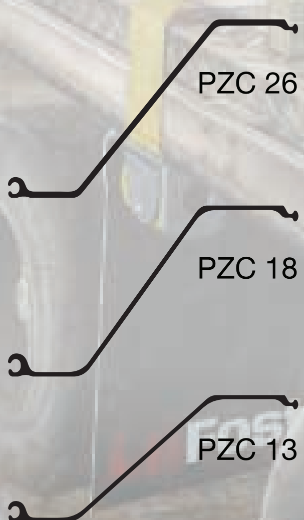

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Extensive knowledge on wood preservation technology and the CCA (chromated copper arsenate) treatment process was shared by Grady Brafford, U.S. sales manager of Arch Wood Protection. His company manufactures various wood preservatives and licenses the production of nationally recognized brands of treated wood including Wolmanized®, Chemonite® and ACZA. Brafford's topics included the composition of CCA, the global positioning of raw materials in the treatment and the EPA-approved uses of the product. Participants learned about standard specifications as set by the American Society for Testing and Materials and the American Wood Protection Association.

Piling engineering methods, construction applications and durability topics were covered by Billy Camp, technical principal, vice president and senior geotechnical engineer with S&ME, Inc. (Charleston, S.C.). Over his 20-year tenure with the company, Camp's primary activities have focused on site characterization, design and testing of deep foundations, earthquake engineering and the development of soft ground sites. Attendees learned about the history of timber piles, early methods of driving and the advantages of the product. They were also treated to interesting photos and discussions of some of the world's most notable timber piling foundations, including the Tower Bridge in London, The Royal Palace in Amsterdam and the San Francisco Ferry Building.

The final Piling Cox College speaker was Harry Robbins, president of Palmetto Pile Driving, Inc. (Charleston, S.C.). Robbins is well known in the industry having served as the national president of PDCA in 2006. Among other topics, Robbins shared the key issues to promote when discussing the use of piling, including the quality of the product and installation, and reliability of the testing. Robbins's presentation was the perfect summary for the day's education and sparked a very insightful question and answer session.

The two-day event was not all work. Braving the frigid temperatures, huddled around heaters under a large tent, the group was treated to some of Cox Industries's famous hospitality, including a delicious "low country boil" of shrimp, smoked sausage, potatoes and corn. Don Surrency, industrial sales vice president for Cox, said, "The evening's networking opportunities proved to be just as valuable to participants as the education itself. Every participant walked away with positive comments on the piling college experience."

Cox Industries plans to host quarterly networking and educational programs in 2009, focusing on the pole and piling industries. For more information on dates and locations consult www.coxwood.com ▼

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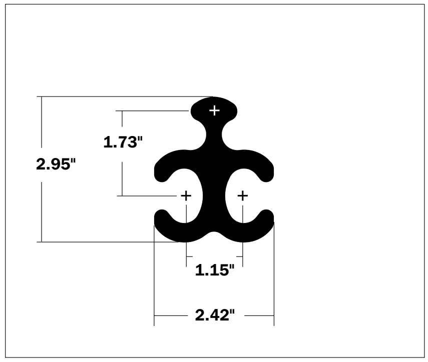
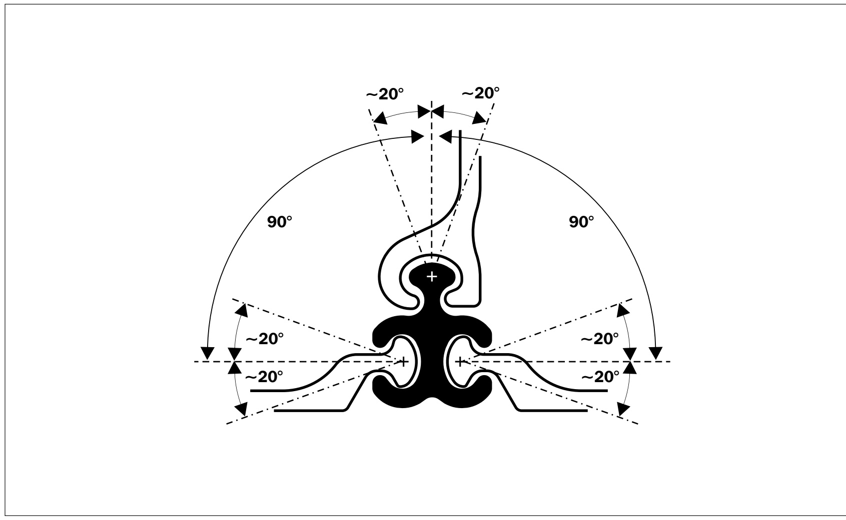
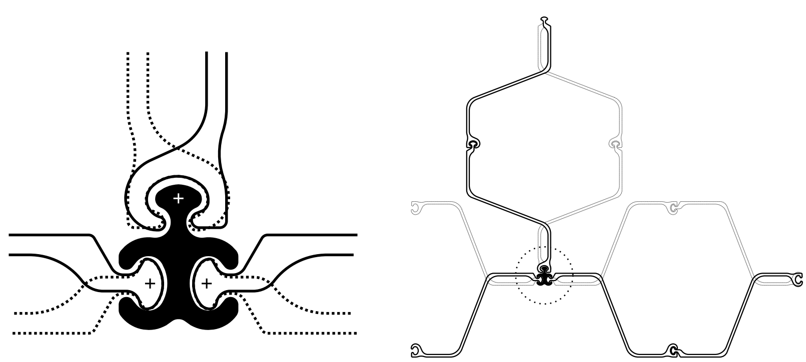
Installation Guidelines

1. General interlocking guidelines call for a ball-to-socket or a socket-to-ball connection. Please review the proper interlocking examples listed.
2. Thread the connector into the interlock while the sheet pile is out of the ground.
3. Adjust the connector to the appropriate position.
4. Tack or spot-weld the connector in place (typically a 10" weld attaching the connector to the sheet pile at the top is sufficient).
5. Drive/extract the sheet (with the connector attached) as you would normally.

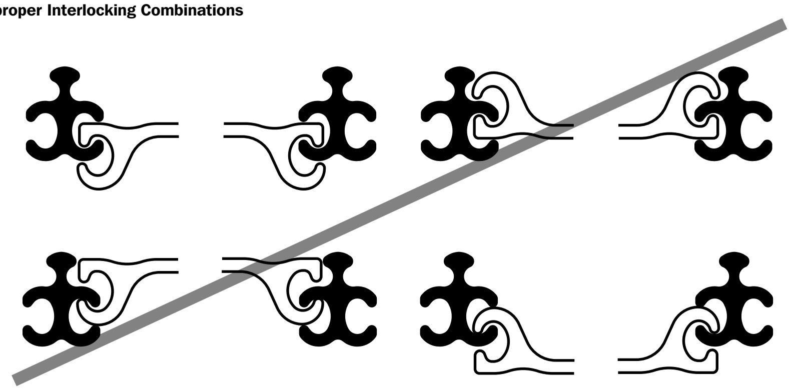




Proper Interlocking Examples



Improper Interlocking Combinations



Please note:

1. Swing or rotation stated are typical but can vary by 10° or more due to rolling tolerances found in sheet pile interlocks.
2. PilePro® connectors are protected by patents.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Pile Driving Contractors Association

International Foundation Congress and Equipment Expo '09
Buena Vista Palace Hotel and Spa Lake Buena Vista, Florida
March 15 to 19, 2009

The PDCA has been talking about the International Foundation Congress and Equipment Expo '09 (IFCEE '09) for almost a year now. But, what is IFCEE '09 and what does it have to do with the PDCA?

Well, here's the lowdown.

In 2006, the PDCA was invited to join with the Geo-Institute of ASCE and ADSC to conduct an international foundation engineering and construction conference that would include the largest foundation equipment and services exhibition ever held.

This vision would become the IFCEE '09, a mega-event scheduled at the Buena Vista Palace Resort and Spa in Lake Buena Vista, Fla.

What about the PDCA's annual conference? This is it. In 2009, the IFCEE '09 will take the place of the PDCA's annual conference.

Along with everything else that will take place at the IFCEE '09, PDCA members will still have a significant amount of PDCA events to focus on; from short courses to technical sessions and committee meetings to our executive committee and board meetings and, of course, the PDCA awards luncheons.

Provided below is a summary of conference activities that await at IFCEE '09.

Short Courses – Sunday, March 15, 2009

- Managing Your Safety Program
- High Strain Dynamic Testing for Driven and Drilled Deep Foundations
- Estimation of Soil Properties for Foundation Design
- Intro to Instrumentation and Monitoring in Geotechnical Engineering

Technical Sessions – Monday, March 16, 2009

- Effective Use of Steel Piles for a Large Transportation Project
- The Effects of Installation Techniques on Capacity of Cylinder Piles in the Yorktown Formation
- Value Engineering of Driven H-Piles for Slope Stability on the Missouri River
- H-Piles Selected for New Power Plant Based on Pre-Award Testing Program and Cost Comparison
- Use of Dynamic Measurements to Drive High Capacity Concrete Piles in Washington's Potomac Foundation
- Geotechnical Design of a Partially Piled Raft Foundation

Tuesday, March 17

- Foundation Engineering of Offshore "Jacket" Structures
- Analyses of Pile Capacity for Offshore Structures in Hurricane Katrina
- Driven Pile Foundations in the Offshore Fields of Qatar: Installation Problems, Challenges, and Potential Solutions
- Driven Pile Capacity in Intermediate Geomaterial Formations
- Measured vs. Predicted Shaft Resistance of H- and Closed-Ended Pipe Piles in Sands
- Steel Innovations: Changing the Economics of Below Grade Foundations

Wednesday, March 18

- Ductile Iron Driven Piles
- Characterization of Precast UHPC Pile Drivability
- The Vibro-jetting Driving Method
- Centrifuge Model Tests on Instability of Automotive Pile Drivers
- Intelligent Pile Driving With a Diesel Hammer
- Ground Vibrations and Dynamic Pile Testing
- Seismic Hazards and Construction Vibrations
- An Overview of Relevant Guidelines for Deep Foundation Vibrations
- Development of a Driven Pile Ground Vibration Case History Database
- Advances in Dynamic Foundation Testing Technology
- Dynamic Pile Testing/Construction Control and Design Verification

Thursday, March 19

- Pile Driving Specifications - A Panel Discussion

PDCA Committee Meetings

Sunday, March 15

- 1 p.m. to 3 p.m. Education
- 3 p.m. to 5 p.m. Market Development

Monday, March 16

- 10 a.m. to 12 p.m. Communications
- 3 p.m. to 5 p.m. Technical
- 5 p.m. to 7 p.m. Environmental

Thursday, March 19

- 7:30 a.m. to 9:30 p.m. PDCA Executive Committee Meeting
- 12:30 p.m. to 2:30 p.m. PDCA Board of Directors Meeting

Social Events

Sunday, March 15

- 6:30 p.m. to 8 p.m. IFCEE '09 Welcome Reception

Monday, March 16

- 7:15 a.m. to 9 a.m. IFCEE '09 Welcome Buffet Breakfast
- 12 p.m. to 1:30 p.m. **PDCA Members Business & Awards Luncheon**
- 6:30 p.m. to 8:00 p.m. Reception

Tuesday, March 17

- 7:30 a.m. to 8:30 a.m. IFCEE '09 Student Meet and Greet
- 6 p m. to 7:30 p.m. GI Terzaghi Lecture - Clyde Baker

Wednesday, March 18

- 6 p.m. to 6:45 p.m. Honoring Our Hero Award Reception
- 7 p.m to 10 p.m. Honoring Our Hero Award Dinner and Dance

Thursday, March 19

- 12 p.m. to 2:30 p.m. IFCEE '09 Student Achievement Awards Luncheon
- 2:30 p.m. to 4 p.m. Peck Lecture - Ed Kavanzanjian, Jr.

One of the most important things to remember is IFCEE '09 is your 2009 PDCA annual conference, with the additional added benefits of more attendees, more educational selections, more exhibitors and more networking.

Don't miss out on this exclusive event. Go to www.ifcee09.org to register or for more information. Rooms are going fast and on a first come, first served basis, so call the Buena Vista Palace at 866-397-6516 today.

Call the PDCA at 888-311-PDCA (7322) for more information. ▼

Chincoteague Channel Bridges

By Bayshore Concrete Products

Chincoteague is a small town on the Eastern Shore of Virginia with roughly 4,000 residents. It hosts more than one million tourists each year and is famous for its annual Pony Swim and Auction.

The Black Narrows and the Chincoteague Channel Bridges on Virginia Route 175 provide the only access to Chincoteague Island. These steel bridges, built in 1939 and 1940, have become costly to maintain and repair, and are narrower than current standards for safety and ease of traffic flow.

The citizens of Chincoteague knew that a new bridge was needed and they lobbied the Virginia Department of Transportation (VDOT) and the Commonwealth Transportation Boards (CTB) for funds to replace the bridges. Environmental concerns, sustainability and the timeline were the major factors in the determination to use pre-cast concrete for this project. The performance and sustainability of pre-cast pre-stressed concrete, combined with the economical advantages and design flexibility, make it the preferred construction material for today's bridge designers. In addition, pre-cast pre-stressed concrete construction reduces installation time by eliminating expensive and time-intensive field formwork.

During the design phase of the bridge, the designers focused on both 24-inch square piles and 36-inch cylinder piles. The 36-inch centrifugal-spun cylinder piles were chosen for their superior engineering properties. The centrifugal-spun cylinder piles minimize the battering of the piles, and the quantity of piles required is less. These benefits are realized without increasing the overall weight of the pile.

In January 2007, American Bridge Company in Richmond, Va. was awarded the contract to build a new bridge with work beginning in March 2007. Bayshore Concrete Products Corporation in Cape Charles, Va. was chosen to provide the pre-cast, pre-stressed concrete components for the new bridge. Bayshore's stringent manufacturing and inspection processes permit a degree of quality control that is almost impossible to attain in the field. Bayshore Concrete Products, a PCI-certified company, is only 50 miles from Chincoteague and has many employees with local connections to the island, which makes it a very special project for the Bayshore Concrete Team.

The new bridge will be three-quarters of a mile (4,035 feet) with a 729-foot connector bridge linking the bridge to Marsh Island. It is expected to be complete in November 2009. The two-lane, 43-foot four-inch wide bridge will also include a

Bascule Bridge to replace the existing swing bridge. The vertical clearance at the Lewis Creek Channel span will be 15'8" that will allow larger vessels to pass underneath and minimize the number of bridge openings.

Bayshore Concrete is providing 295 centrifugally cast cylinder piles, approximately 26,300 linear feet. Each pile is 36 inches in diameter ranging from 80 to 104 feet in length with a 6-1/2" wall thickness and 12 tendons each. The concrete compressive strength is 7,000 psi at 28 days and 4,000 psi at time of post tensioning. The concrete contains 2 gallons of calcium nitrite corrosion inhibitor per cubic yard and 40% replacement slag. With this high-performance concrete mix, the bridge owner is anticipating the structural life of the bridge to be 100 years or more.

Bayshore Concrete is also providing 13,458 linear feet of PCBT Beams. These beams range in length from 34 feet to 83 feet and include embedded galvanized bearing plates. In addition, Bayshore Concrete is supplying 120 Arch Fascia Beams at 19 to 83 feet long per beam, which make up both sides of the bridge's exterior.

Cylinder piles are made in 16-foot long sections. The sections are centrifugally cast from zero slump concrete. Holes are provided in the wall of the cylinder pile section for post tensioning cables that will ultimately be used to stress the sections together to make a one piece pile. Piles are available in three outside diameters: 36 inch, 54 inch and 66 inch. The centrifugal casting process produces a dense, low permeability concrete that is ideally suited to the marine environment.

Once sections are cast and cured to the 4,000 psi they are stressed together (assembled) to make the required pile lengths. Epoxy paint is applied in the splash zone for protection against chloride ion intrusions. Bayshore Concrete has produced a 54-inch diameter, 200-foot-long pile for the Staten Island Berthing Pier in New York.

All of the pre-stressed products for the Chincoteague Bridge have been made in Bayshore Concrete's Cape Charles, Va. Facility that occupies 90 acres on the Chesapeake Bay and includes 1,000 feet of bulkhead waterfront serviced by mobile cranes and gantries for easy loading of product onto barges for shipment. All of the products for the Chincoteague Bridge were shipped to the construction site by barge.

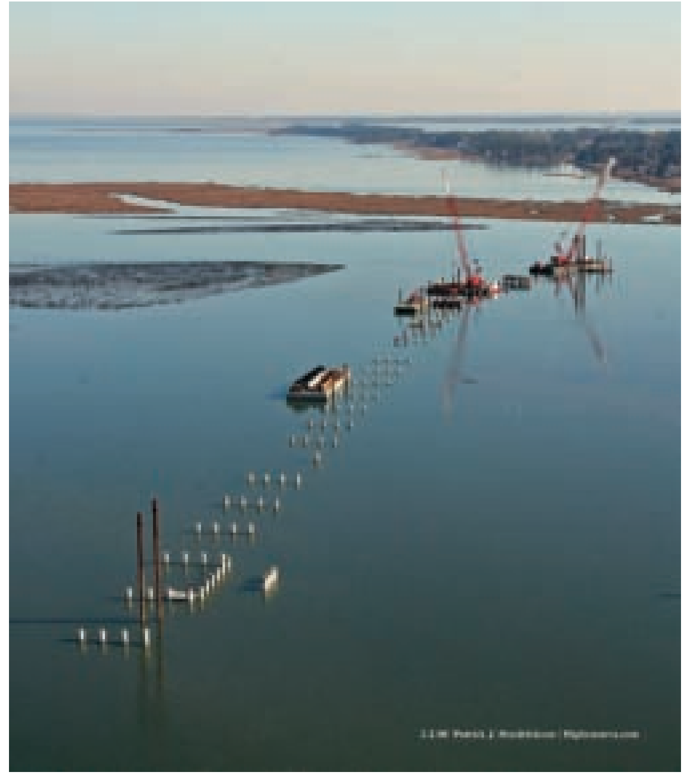
Construction began in March 2007, with driving the test piles. To date, approximately 274 pre-cast, pre-stressed cylinder piles have been driven into place using a barge-mounted Bruce 2015 hydraulic hammer which has a RAM weight of 44,092 pounds and maximum potential energy of 216,990 ft lbs.

Fifty-four piles were driven below the mud line for the bascule footing. Piles were driven inside a cofferdam and are typically driven in pier bents within a template frame. Bents ranged from three to five piles each. American Bridge expects to complete the project on time in November 2009.

Challenges faced in constructing the bridge included the location which is in an environmentally sensitive area. Due to shallow water, a total of six temporary work bridges are needed for equipment access. In addition, crews had to work around the schedule of the Colonial-Nesting water bird that chooses to mate and nest in the waters surrounding Chincoteague Island. Both pile driving operation and use of artificial light were restricted for a five-month period each year while the birds mated and nested. American Bridge was prepared for the environmental concerns and scheduled work away from the marshes during the nesting season. Additionally, two-way traffic was required to be maintained during the summer months because of the influx of tourists to Chincoteague and Assateague Island beyond.

Bayshore Concrete was established in 1961 to produce the pre-cast concrete components for the 17-mile Chesapeake Bay Bridge-Tunnel. Over the years, Bayshore Concrete has expanded its product line to include pre-cast and pre-stressed concrete for marine facilities, mass transportation, parking structures, offshore structures, piers, and heavy construction in addition to the manufacturing of girders, segments and piles for bridges. Bayshore Concrete also has a plant in Chesapeake, Va. This 25-acre site is situated on the Elizabeth River and mainly produces square piles and double tees. Bayshore Concrete is committed to providing sustainable components and protecting the environment for future generations. All Bayshore products are made with materials purchased within the United States, utilizing recycled materials whenever feasible.

Bayshore Concrete Products is owned by Skanska, one of the world's leading project development and construction groups; with expertise in construction, development of commercial and residential projects and public-private partnerships. The group currently has 60,000 employees in selected home markets in Europe, the U.S. and Latin America. Headquartered in Stockholm, Sweden and listed on the Stockholm Stock Exchange, Skanska's sales in 2007 totaled SEK 139 billion. ▼



Innovative Combination

Steel sheet piling and press installation help a California project break new code ground

By Jason Thompson, KPFF Consulting Engineers, and Chris Zadoorian, GeoDesign, Inc.

Over the past few years numerous high-rise projects have been initiated in downtown Los Angeles, but the new 23-story Evo South changed business as usual and opened new doors for future construction methods.

Evo South includes a 23-story residential condominium tower over three subterranean levels. The 60,000-square-foot rectangular footprint of the below-grade levels occupies the entire project site. Bordered on three sides by streets and on the remaining side by an 11-story residential tower, the construction staging area was tight. The project used a modified up-down construction sequencing, which allowed the construction of the building superstructure to proceed in tandem with mass excavation and construction of the below-grade levels.

Up-Down Construction

Although the up-down construction process has been employed in congested urban environments, the technique had only been used twice in Los Angeles in the early 1980s. By selecting an up-down methodology for the southern two-thirds of the project site beneath the tower footprint (nicknamed the "up-down zone"), the overall construction schedule was reduced by approximately two months. The developer's gains were twofold: reduced costs from carrying the construction loan and earlier tenant occupation. The northern half of the site – the "conventional zone", encompassed the northerly portion of the below-grade parking garage, the ground level plaza, and the sixth-floor terrace – was completed using conventional methods following prior excavation down to the P3 basement level.

The process began by advancing sheet piling to a depth of 15 feet below the eventual P3 basement level on the east, west and south sides of the site. The AZ 36 sheet piling, with an 18-inch deep profile and nearly three-quarter inch flange thickness, would serve as the temporary shoring for excavation support and ultimately the finished basement walls. With the sheet piling in place, excavation was performed to lower the grade across the site (up-down and conventional zones) down one story to the underside of the P1 basement level. Temporary shoring was not needed since the sheet piling was capable of cantilevering the single story. The team installed tiebacks through the sheet piling within the conventional zone to allow further excavation in a subsequent stage. A temporary construction ramp was erected on the northern side of the site provided access into and out of the excavation.

After completion of the initial one-level excavation within the sheet piling, the foundation system for the tower columns and shear wall cores, consisting of large diameter drilled shafts were installed within the up-down zone. The reinforced concrete drilled shafts extended 40 to 90 feet below the eventual P3 basement level, but were terminated at the P-3 level to allow for the installation of pre-cast columns. The pre-cast columns were then set atop the drilled shafts within the remaining hole between the P3 and P1 basement levels. With the columns and drilled shafts in place, the P1 slab was then poured on grade. At this point, tower construction could proceed upward while downward excavation continued.

Excavation beneath the P1 slab proceeded much like a mining operation down to the eventual bottom of the excavation immediately below the P3 basement level. Since the P1 slab now effectively braced the sheet piling basement walls, there was no need for tiebacks within the up-down zone. These walls are capable of spanning between the bottom of excavation and the P1 level.

Sheet Piling

The steel sheet piling was utilized as both the temporary shoring and permanent basement wall construction. While this technique has been successfully employed in Europe and in a few locations in the United States, it was a new and unproven technology to the City of Los Angeles, and a first for California.

The team selected the system for both its speed of installation and its advantages in facilitating up-down construction. Because the project employed the same standard section of sheet piling used more typically for marine and other foundation applications, it also was readily available. Furthermore, sheet piling installation could be made with the same tolerances as conventional concrete construction.

For the temporary shoring condition within the conventional zone, the sheet piling was designed as part of a braced system that included tie-back anchors. For the permanent wall below grade condition, internal bracing is provided by the P3, P2, P1 and ground level floor slabs. Due to the potential for periodic perched groundwater, the lower section of the sheet piling was designed to resist hydrostatic pressure in addition to the active soil pressure loading.

Press-in Technology

Sheet piling is traditionally driven in sections with vibratory or impact hammers, with sections joined at vertical interlocks. Because loud hammering or vibration on neighboring buildings in the downtown environment occurs, a “silent” press piler hydraulically jacked or pressed the sheets of piling into place. As a vibration-free installation technique, the press piler also avoids environmental disruption such as ground settlement and soil disturbance.

Giken America Corporation provided two SCZ-675SM model Crush Pilers that are fitted with an internal auger for the job. Giken’s U.S. Regional Manager Mike Carter said the two machines helped maintain the project schedule despite difficult soil conditions.

“With the very dense sand, cobbles and gravel, the sheet piles were driven as singles since the SCZ675SM Crush Auger has a more effective augering coverage area. We offset the potential decrease in overall productivity from driving single sheet piling by using two machines.”

The machinery was laser guided and utilized the reaction force derived from fully installed piling as a counter weight to hydraulically press-in subsequent sections of piling. The systemized equipment was also self-advancing. Since the Super Crush Piler operates at typical sound levels of only 69dB, using two shifts per machine to accelerate the piling schedule still only resulted in the noise roughly the equivalent of that made by a semi-truck, and vibrations were virtually non-existent.

The pre-drilling at the leading edge of each single sheet facilitated advancement of the sheet piling through the gravel and cobbles in the upper 20 to 30 feet of the subsurface soil. This pre-drilling loosened the soils and effectively reduced the lateral confining stresses. A total of approximately 400 sheet pile half-sheet sections were installed to a depth of roughly 46 feet, providing a total of approximately 800 lineal feet of sheet piling basement wall.

At this site, the pre-drilling would have had to achieve depths of approximately 20 to 30 feet below the P1 level.

According to Carter, production rates using the Silent Piler in soft to medium dense soils are comparable to that of conventional vibratory equipment for production and cost per square foot, and higher in production rates in very dense conditions using the Super Crush system.

"The feedback we've received is that the pricing and productivity are comparable to conventional vibratory equipment," said Carter.

Piecing It Together

The project site is located within a designated methane zone, and protection from methane seepage into the building was required. Following excavation, the interlock seams joining individual sections of sheet piling were welded with non-structural seal welds, which were then subjected to periodic visual inspection and a magnetic particle testing program. These welds completed a basement wall construction impervious to water and methane, which eliminated the need for a separate membrane barrier on the walls' backside.

Where sheet piling walls terminate, a direct positive connection along the vertical joint between the sheet pile and adjacent concrete wall construction was required. For example, at the northwest corner of the site, a continuous steel angle was used to connect the sheet piling wall with an existing concrete Los Angeles Department of Water and Power vault wall. This angle was secured to the sheet piling with a continuous fillet weld and to the vault wall with adhesive anchors. At the other few locations where sheet piling was not used, such as at the northeast corner of the site, deformed dowel bar anchors were welded to the last section of sheet piling and lapped with horizontal reinforcing within the adjacent shotcrete basement wall.

At the connection between ground floor slab and perimeter sheet piling walls, welded deformed bar anchors transfer wind and seismic diaphragm forces from the tower's interior core walls to the sheet piling. In-plane forces are then transferred from the sheet piling into the adjacent soil.

Permitting

Approval for the use of sheet piling as a permanent basement wall for building construction was an extensive undertaking. In collaboration with the City of Los Angeles Department of Building and Safety, and in response to the various plan check comments (which were numerous for this project due the innovative and precedent design and construction methodologies), the design team, general contractor, sheet piling manufacturer and sheet piling installer compiled a full book of explanations and clarifications. One major concern was the longevity of the sheet piling and its resistance to corrosion and fire. The sheet piling manufacturer, Skyline Steel, was instrumental in obtaining test data on the system.

"Using permanent sheet piling for the foundation wall created the opportunity for the project team to explore cost savings in both material and critical path schedule," said Dean Abbondanza, business development manager at Skyline Steel. "But, the City of Los Angeles has some of the most demanding building code requirements. During the permitting process, we entered into areas of design and construction codes that we didn't know existed. It was a total team effort to get our sheet piling application approved."

Although the sheet piling has the inherent capacity to withstand the downward structural loads of the tower above, the City of Los Angeles required it to qualify as a four-hour fire rated assembly in order to be considered for gravity load-carrying basement walls. During the project's design phase, test data on four-hour fire resistance of the sheet piling basement wall assembly was not yet available. To mitigate the concern, the team installed perimeter concrete columns around the inside of the sheet piling wall to carry the perimeter gravity loads. Since the project's design, the sheet piling assembly has successfully completed four-hour fire testing by an approved agency, which will allow sheet piling basement walls to carry gravity loads in future projects.

Conclusion

The use of sheet piling basement walls facilitated the up-down construction method on this project resulting in an approximate two-month savings in the construction schedule. Because the sheet piling was also utilized as the temporary shoring and finish basement walls along three sides of the site – with no need for footings or piles for support – it provided additional advantages. The system reduced expense and material waste by serving as both the temporary shoring and the impervious finished basement wall, and its recycled steel construction makes Evo South a more environmentally friendly building.

Jason Thompson, P.E., S.E. is an associate at KPFF Consulting Engineers in Portland, Oregon. Chris Zadoorian, GE is a principal engineer at GeoDesign, Inc. in Anaheim, California.

▼

Evo South Project Team

Developers:
Gerding Edlen Development and Williams & Dame Development (joint venture)

Architects:
GBD Architects and TVA Architects (joint venture)

General Contractor:
Howard S. Wright Construction

Structural Engineer:
KPFF Consulting Engineers

Geotechnical Engineer:
GeoDesign, Inc.

Piling Manufacturer:
Skyline Steel

Piling Installer:
Giken America

Sheet Piling & Grouting Project Accomplishes Emergency Repair Project for Allegheny River Lock No. 6

Background:

Brayman Construction Corporation performed a $2.9 million emergency repair on the United States Army Corps of Engineers (USACE) Allegheny River Lock and Dam No. 6, located outside of Pittsburgh, Pa. Emergency work to the 80-year-old dam was due to severe erosion discovered during a recent inspection. The project included the installation of a 230-foot long sheet pile wall and tremie placement of approximately 800 cubic yards of concrete between the installed sheet pile wall and existing dam structure to fill the massive void of the eroded area.

Figure 1

Allegheny Lock and Dam No. 6 as shown in Figure 1 is one of eight navigation facilities on the Allegheny River. Construction of Lock and Dam No. 6 started in 1927 and opened for river traffic in 1928. The 992-foot-wide by 12.4-foot-high dam structure has a single 56 ft x 360 ft lock chamber located on the west side, and also features a 9.5 megawatt hydroelectric plant located on the east side. Consistent with construction practices of the time, Lock and Dam No. 6 was built on timber pilings. Steel frames were placed on top of the pilings, and the concrete dam was poured and shaped on top of the frame. In efforts to prevent erosion at the base of the dam, timber cribbing and stone were placed along the downstream side of the structure.

In early October 2008, divers completed a periodic survey of the dam. Although some erosion was expected, the extent of erosion surveyed, as graphically depicted in Figure 2, led inspectors to determine that repairs were needed immediately to prevent failure of the dam. Specifically, the underwater inspection identified an area of erosion, or scour, along an approximate 200-foot section of the dam that extended approximately 29 feet under the existing structure in an area of the dam directly adjacent to the existing hydroelectric facility.

Based on the findings of the October inspection, it was concluded that the identified erosion threatened to undermine

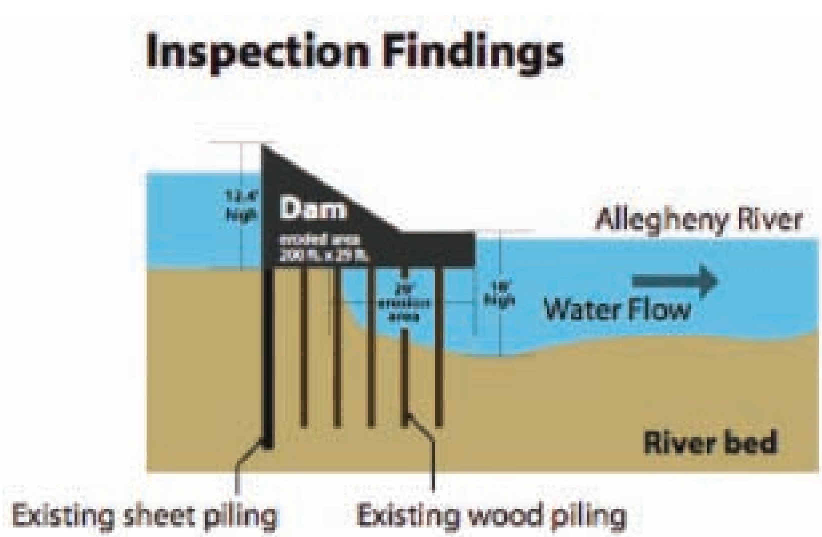


Figure 2

the stability of the dam. The major concern was that periodic high river flows and/or ice loads on the dam from large chunks of ice slamming into the dam could potentially knock the concrete structure off its exposed wood piling and into the river. It was also determined during the inspection that this entire section of the dam was predominantly supported by the original wooden pilings driven into the riverbed when the dam was built.

Should failure occur, it was concluded that serious impact to the region would result. Specifically, a loss of the pool would shut down commercial and recreational navigation on the river until the dam was replaced or repaired. In addition, severe water degradation would impact water intakes and sanitary facilities, and the hydropower facility located at the dam could potentially incur severe damage and cease operations. Other impacts such as the potential depletion of one of the area's largest wetlands would occur, as would a negative impact of the federally listed endangered mussel species. As such, the repairs were deemed "critical." The repairs were designed and initiated in record time. With the project awarded to Brayman Construction in early November 2008, the project team was mobilized and started working on Nov. 17, 2008, with critical dam repairs substantially completed by mid-January 2009.

Project Approach:

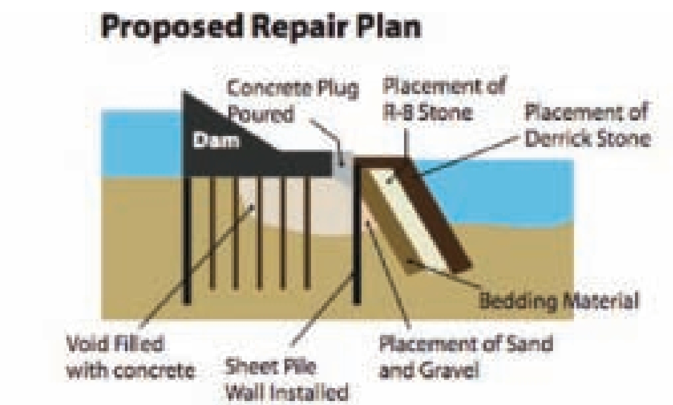


Figure 3

The planned repairs to Lock and Dam No. 6 (as graphically depicted in Figure 3) consisted of placement of sheet pile wall along the toe of the dam to seal off the void, and installing rock and engineered fill downstream of the piling for additional slope stabilization. The plan also called for tremie placement of approximately 800 cubic yards of concrete between the installed sheet pile wall and existing dam structure to fill the massive void of the eroded area. Additionally, a series of holes or portals would also be drilled through the existing concrete dam structure for additional placement of tremie concrete under the structure to ensure complete filling of the eroded areas.

The water-based project was accomplished by the Brayman Construction Corporation's Marine & Piling Group working closely with the USACE's Pittsburgh District. To complete the repairs to the structure, a portion of the river flow was diverted through the hydroelectric plant – owned by Sithe Energy. As water levels fluctuated, as shown in Figure 4 and Figure 5, work schedules were adjusted accordingly.

Figure 4

Figure 5

Figure 6

Figure 7

The project was performed entirely by marine-based equipment positioned on the downstream side of the dam, as shown in Figure 6.

Piling Operations: Placement of Sheet Piles

The initial step of the multi-stage repair process consisted of placing sheet piles at the downstream side of the existing dam structure, as shown in Figure 7. The line of sheet piling was

Figure 8

positioned approximately two feet from the downstream side of the apron. Placement of the piling consisted of two 14 x 89 H-Piles located at each end and 230 lineal feet of PZC-26 sheet pile - all averaging 40 feet in length. The purpose of the pile wall was to act as a form to allow the back-filling of the existing voids under the dam with concrete. The material was delivered to the site, and stored on barges until installed with a vibratory hammer.

Sand and Gravel Placement

Upon installation of sheet piling, approximately 1,000 cubic yards of sand and gravel were delivered from Allegheny Minerals Corporation, located 10 miles up the Allegheny River and placed on a 2.5:1.0 grade on the down river side of the installed piling. The material was placed prior to the initial concrete installation to counteract the anticipated concrete loading on the sheet pile, as shown in Figure (8). The sand and gravel also acted as the base course for the scour protection downstream of the dam.

Grouting Operations: Filling the Voids

Initial tremie concrete placement to fill the majority of the existing void was made between the downstream edge of the apron and the sheet piles. Additional tremie concrete was placed through a series of 10-inch holes drilled in the dam, as shown in Figure (9). These holes were drilled in two lines approximately 8 and a half feet apart – starting at the powerhouse and proceeding across the dam until the voids beneath the dam were no longer present. The second stage of tremie concrete placement through the drilled holes started at the furthest point on the dam and moved back toward the powerhouse. When river conditions recede to more manageable levels, a high-strength concrete "cap" will be placed between the top of the sheet pile and the apron of the dam.

The tremie concrete for the filling of the significant voids beneath the dam was engineered to meet the specific requirements of the contract. As part of the concrete mix design, specific additives were incorporated into the mix to prolong the initial set for a maximum of six to seven hours – yet still obtain a final set in approximately 15 hours. In order to reach all the voids beneath the dam, the concrete also needed to achieve a minimum slump of 7 inches. Through the use of water-reducing agents, self-consolidating admixtures, and anti-wash agents, a viable concrete mix was developed and incorporated into the repairs at Lock 6.

Figure 9

The sheet pile installation, placement of sand and gravel, placement of AASHTO #1 bedding stone, as well as drilling of tremie holes and tremie concrete work was all completed by Jan. 14, 2009. During repair operations, on-site work was periodically halted due to the high water fluctuations of the river. Additional work, consisting of placement of approximately 4,360 cubic yards of R8 rip-rap and placement of approximately 3,333 cubic yards of derrick stone, as well as the high-strength concrete cap will be completed once river levels recede to more manageable levels. The work completed to date has significantly improved the condition of the dam and greatly reduces the risk of damage from high water flows and ice.

Full Service Contractor:

Brayman Construction Corporation, headquartered in Saxonburg, Pa. is a full-service provider of general contracting and specialty geotechnical construction solutions throughout the entire eastern United States. The work performed for this emergency repair project is consistent with the diverse capabilities of Brayman's Marine & Piling Group. The capabilities of this Group continue to gain significant recognition for its proven ability to safely and successfully deliver innovative marine and piling solutions on the inland waterways systems of the United States, as well as on non-navigable rivers, reservoirs, and lakes. Brayman also provides diverse piling solutions in numerous non-marine applications. For more information about Brayman and its diverse capabilities and project experience, visit www.braymanconstruction.com ▼

Quantico Marine Corps Base

Construction of aircraft maintenance hangars takes off on soft ground

By Hamid M. Riahi, Vice President, PE (Haley & Aldrich, Inc.) and Derrick A. Shelton, Project Manager, PE (Haley & Aldrich, Inc.)

OVERVIEW

The hangar complex consists of the Whiteside and Greenside aircraft maintenance hangars located at the Marine Corps Air Facility at Quantico Marine Corps Base in Quantico, Va.

The two hangars support the Fleet Marine Force and the HMX-1, which is the helicopter transport squadron for the president of the United States. Supporting functions such as administrative office space, storage areas, briefing rooms, maintenance shops, flight crew support rooms, and associated mechanical and electrical support spaces are housed in an adjacent building abutting the hangars.

Despite being connected, each of the two-story hangars has separate functions. The Whiteside Hangar has a footprint of 180,252 square feet (4.1 acres) and is used to support the executive branch of the U.S. Government. The Greenside Hangar has a footprint of 61,149 square feet (1.4 acres) and is used to support the rest of the HMX-1 fleet.

Each of the maintenance hangars has an exoskeleton superstructure consisting of a cantilevered design providing column-free space for the maintenance bays. The hangar superstructure consists of a structural steel frame. The lowest finish floor level is constructed as a reinforced concrete structural slab. Concrete aircraft parking aprons are located to the east of both hangars.

Design and construction of the hangar complex was procured by NAVFAC (Washington, D.C.) as a design-build project. Haley & Aldrich was the geotechnical engineer of record. HSMM was the Architect and was responsible for structural design of the hangar floor slab and pile caps. Cagley & Associates was responsible for design of the steel superstructure. Clark Construction was the general contractor and Clark Foundations installed the driven piles.

Subsurface Conditions

The Potomac River is located immediately east of the Marine Corps Air Facility. The proximity of the Air Facility to the Potomac River has significantly influenced the depositional nature of the subsurface soils that underlie the site. The subsurface conditions consist of approximately five feet of new sand fill underlain by 15 feet of existing sand and silt fill. The B1 stratum is located below the fill strata and consists of a 30-foot-thick layer of very soft to soft organic silt and clay. The B1 stratum is underlain by the B2 stratum, which consists of a 20-foot-thick layer of medium stiff silt and medium dense to dense sand and gravel. The C1/C2 stratum is located below the B2 stratum and consists of hard silt and dense sand of the potomac group. The

NEW FILL	SAND Unit Weight = 115 pcf, Φ = 30°	0 ft
EXISTING FILL	SAND and SILT Unit Weight = 115 pcf, Φ = 30°	5 ft
B1 (Upper)	ORGANIC SILT and CLAY Unit Weight = 90 pcf, S_u = 470 psf	20 ft
B1 (Lower)	Unit Weight = 90 pcf, S_u = 600 psf	35 ft
B2 (Upper)	SILT and SAND Unit Weight = 115 pcf, Φ = 32°	50 ft
B2 (Lower)	SAND and GRAVEL Unit Weight = 130 pcf, Φ = 38°	65 ft
C1/C2	SILT and SAND Unit Weight = 130 pcf	70 ft

groundwater level is typically located at a depth of five feet below finished grade. A generalized soil profile is shown below.

Geotechnical Design Issues

To construct the proposed structures, the existing grade needed to be raised by approximately five feet. During the procurement process, the following major geotechnical issues had to be evaluated and resolved in order to construct the proposed structures:

- Supporting the proposed structures on loose existing fill and very soft alluvial soils of stratum B1;
- Considering downdrag forces on a deep foundation system due to fill placement above the 30-foott-thick layer of compressible B1 stratum soils;
- Improving the existing soils outside of the building limits for direct soil support of the proposed aprons, roadways and parking areas at the desired elevation;
- Accelerating the settlement and strengthening the alluvial soils using wick drains and surcharging or other ground improvement techniques;
- Maintaining post-construction total and differential settlements within 1 inch and half-inch limits, respectively;
- Considering the impact and effects of the proposed construction on adjacent existing, future structures and utilities;
- Accommodating seismic ground motion in the building design; and
- Selecting an appropriate, feasible and cost-effective foundation system for support of structures.

Criteria Used to Evaluate Different Fill and Consolidation Issues

Criteria	Description
Long-term Effectiveness	Evaluate impact of selected option on existing utilities, which could have a potential for long-term failure and requires substantial repairs.
Long-term Risk	Evaluate the long-term risk of the selected option.
Long-term Foundation Performance	Evaluate the long-term effectiveness, reliability, and efficiency of selected foundation support system to accommodate the contract requirements.
Implementability	Consider the technical and administrative feasibility of the selected option, as well as availability of required resources (e.g., suitable fill material).
Construction Impact	Evaluate impact and interference of construction activities and utility shutdowns on daily base operation.
Long-term Reduction in Settlement Monitoring Program	Assess impacts of long-term reductions in settlement.
Best Value	Evaluate the capital costs for construction, engineering services, and project administration; and operation and maintenance costs for labor, materials, and administration. Provide the best value to the base.

Geotechnical Approach and Design Considerations

The criteria listed in the table above were used to develop feasible and appropriate solutions for constructing the hangars, buildings, utilities, and roadways. Using these criteria, the following alternatives were evaluated for construction of the roadways, parking lots, and hardscaping on the Landside (west side of the hangar).

Landside Alternative 1

This first alternative for the Landside consisted of raising the existing Landside grade by five feet following the use of ground improvement techniques such as soil-cement mixing, vibrated concrete columns, jet grouting, deep-dynamic compaction, or wick drains. The intent of this alternative was to strengthen the B1 stratum soils in order to reduce the potential for future settlement. During the evaluation process, it was determined that this alternative was not a practical solution and could not completely improve the ground conditions so that long-term settlement did not exceed the limits established for the project.

Landside Alternative 2

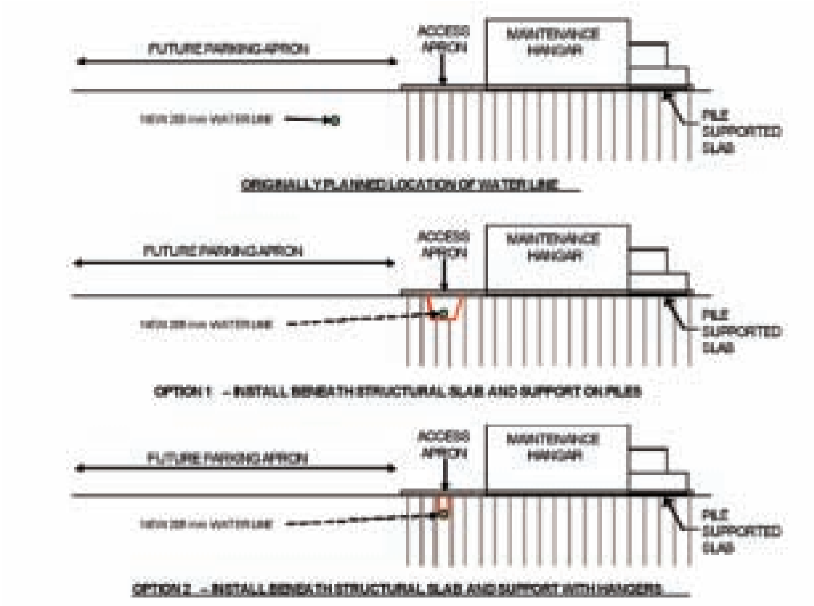
The second alternative for the Landside included raising the Landside grade to the minimum amount required to promote positive drainage and over-excavating the subgrade of the new roadways and parking lots to a depth of three feet below the existing grade, and three feet (laterally) beyond the footprint of the proposed pavement sections. Following over-excavation, the roadway subgrade and parking lot subgrades would be constructed using VDOT No. 57 stone reinforced with geogrid. Of the two alternatives, this option was determined to be the most feasible solution because no ground improvement was necessary. More specifically, it was determined this alternative would significantly reduce: 1) the quantity of fill placement and compaction; 2) the potential for short-term and long-term settlement of the existing utilities; 3) risk to the owner and general contractor related to unforeseen conditions associated with potential utility relocations; and 4) disruption to base activities.

Airside - Hangars, Buildings, Aprons and Underground Tanks

Similarly, the criteria listed in the table were also used to evaluate foundation support of the hangars, buildings, aprons, and underground storage tanks on the Airside (east side of the hangar). As a result of our evaluation it was decided to support the Airside hangars, buildings, aprons, and underground tanks on deep foundations, consisting of 12-inch and 14-inch square pre-cast pre-stressed concrete (PPC) piles installed into the dense C1/C2 stratum soils of the potomac group. A technical challenge associated with this decision was designing the piles to support the axial structure loads as well as downdrag loads (negative side resistance) created by the settlement of the compressible 30-foot-thick layer of Stratum B1 soils. This settlement will occur primarily as a result of the surcharge created by the approximate 5-foot-thick layer of new fill that will be placed to raise the site grades. As a result of the anticipated settlement, the design-build team decided to design the lowest-level floor slabs within the hangars as pile-supported reinforced concrete structural slabs rather than as slabs-on-grade.

Settlement of New Utilities

Several strategies were evaluated and implemented for the installation of new utilities and controlling the differential settlement between utilities and structures. The first strategy consisted of relocating planned utilities from areas where significant settlement was anticipated to be beneath the structural slab. The primary advantage of this strategy was that by installing the utilities beneath the structural slab, they could either be supported by driven pile foundations or hung from the structural slab. The figure below illustrates the strategy of relocating the utilities from their originally planned location



to beneath the structural slab. Another strategy included using flexible connections (where feasible) to ease the transition between structures and unsupported utilities and between supported utilities (pile supported or hung from the structural slab) and unsupported utilities. Delaying the final utility connections as long as possible was another strategy that proved effective.

Design of Pre-cast Pre-stressed Concrete (PPC) Piles

A combination of 12-inch square and 14-inch square PPC piles was used to support the hangar floor slab, interior columns, and exterior columns. The design of the PPC piles presented several challenges. Due to the configuration of the structure and the 40- to 50-foot-thick layer of existing fill and soft, compressible alluvial soils, the piles needed to be designed to handle axial compression loads, tension loads, lateral loads due to seismic and static forces, and downdrag loads.

Site-specific seismic and lateral analyses were performed to model the behavior of the piles subjected to seismic and static lateral loads. The results of the analyses indicated that 12-inch. PPC piles could be used to support the slab and interior columns, but 14-inch PPC piles would be required to support the exterior columns. In addition, HSMM designed the connection of the piles to the pile caps as a pinned connection so that the pile caps were free to rotate without causing the pile heads to rotate. Thus, no momentum was transferred from the structure to the piles.

The piles used to support the hangar floor slab and superstructure will be subjected to downdrag loads (negative side resistance) created by settlement of the compressible 30-foot-thick layer of Stratum B1 soils. The results of our analyses indicate that the maximum downdrag load for the 12-inch and 14-inch PPC piles would be 40 tons and 47 tons, respectively, along the upper 50 feet of each pile.

The piles were designed as friction piles and derive the majority of their capacity in side resistance within the B2 and C1/C2 strata. The ultimate capacity of the 12-inch and 14-inch PPC piles was 260 tons and 284 tons, respectively. As a result, a minimum concrete compressive strength of 6,000 psi was required along with an effective prestress of 1,000 psi. The ultimate capacities were determined using the IBC 2003 building code and the results of the indicator test pile program discussed later in this article. When considering the factor of safety and downdrag loads, the calculated allowable capacity of the 12-inch and 14-inch square PPC piles was 90 tons and 95 tons, respectively.

Pile Installation

Prior to installation of the production piles, an indicator test pile program was prepared and implemented by Clark Foundations to determine the ultimate pile capacity and driving criteria under actual field conditions. The test pile program consisted of installing nine indicator piles consisting of both 12-inch and 14-inch PPC piles. The data collected from this program along with engineering analysis performed by Haley & Aldrich were used to determine estimated pile lengths, end of initial drive (EOID) blow count criteria, and re-strike blow count criteria. The test pile program was performed in four stages:

1. Each indicator pile was driven into the dense C1/C2 soils of the potomac group and instrumented with a Pile Driving Analyzer (PDA). The PDA data, Case Pile Wave Analysis Program (CAPWAP) and wave equation analyses were used to determine the ultimate pile capacity, EOID blow count criteria, and hammer stroke per foot.
2. A re-strike was performed on each indicator pile, 48 hours after the initial drive and additional PDA and CAPWAP data were obtained.
3. During production pile installation, approximately 25 additional PDAs were performed to fine-tune the blow count criteria developed from the indicator pile program. The following blow count criteria were used for acceptance of piles for full capacity: EOID: 50 blows per foot for the final two feet of driving Re-strike: 20 blows per inch
4. A static load test was performed on one of the 12-inch PPC piles and successfully verified the capacities determined using PDA and CAPWAP.

The following picture shows PPC piles installed to varying depths within the C1/C2 bearing stratum, prior to being cut to the required cutoff elevation.

The major equipment used during the installation of the indicator and production piles included:

1. A 75-ton service crane for offloading piles at the designated stockpiling area;
2. One 150-ton Linkbelt crane serviced by one 100-ton service crane;
3. A Delmag D30-32 diesel pile driving hammer;
4. Box leads with spotter attachment;
5. A hydraulic saw and power pack; and
6. An oxygen/acetylene cutting torch.

Clark Foundations installed a total of 1,212 piles in five months using two crews. Installed pile lengths generally ranged from 65 to 95 feet and totaled 87,605 linear feet. As illustrated below, once the piles reached a length of 75 feet, Clark Foundations had to use a three-pick point crane to place the pile under hammer.

Upon completion of installation, testing, and approval of each pile, Clark Foundations attempted to use a Tate Pile Cruncher (shown below) and a Pile Beaver to cut each pile to the required cutoff elevation. Because these two cutters could not provide a clean cut, Clark Foundations decided to use a hydraulic saw to cut the piles.

Acknowledgements: NAVFAC Washington; HSMM; AECOM; Cagley & Associates, Inc.; Clark Foundations, LLC; Clark Construction; D.W. Kozera, Inc.; and Atlantic Metro-Cast, Inc. ▼

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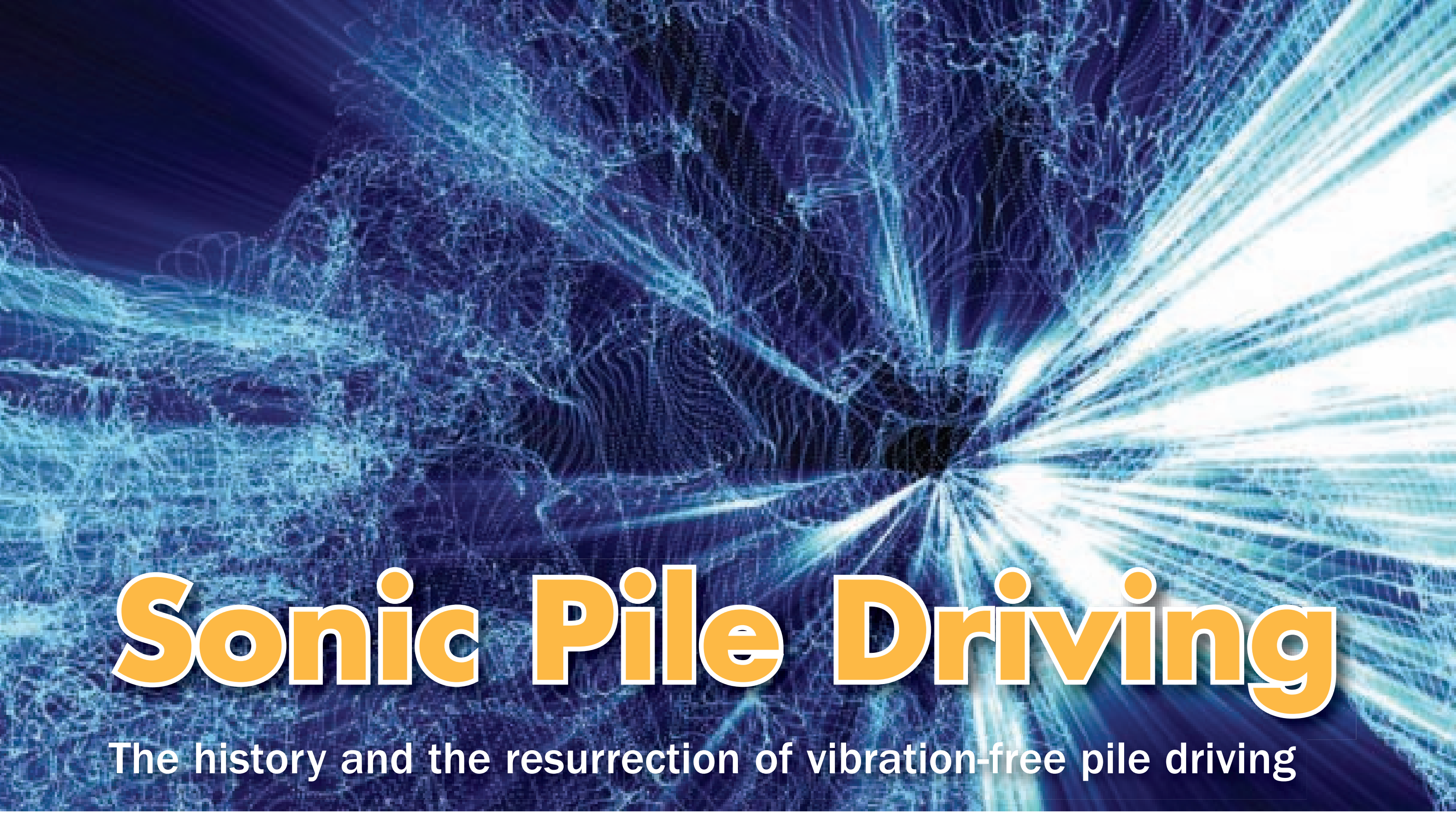


Sonic Pile Driving

The history and the resurrection of vibration-free pile driving

By Matthew Janes, MESc, PEng, MBA, Vancouver, British Columbia, Canada

The installation of piles and casings is becoming increasingly difficult as crippling restrictions on vibration become common in major urban areas. Conventional impact and low-frequency vibratory methods are becoming less available to the contractor to advance piles. High-frequency conventional vibrators are able to reduce the measured ground vibration in many situations, however, they often cannot meet the restrictive limits imposed and may not be used immediately adjacent to sensitive structures. The use of super high-frequency (up to 150 Hz or 9000 VPM) "sonic" or "resonant" pile drivers has proven in the past to permit ease of installation of sections to great depths with near imperceptible ground vibrations as close as one pile diameter. Early work in the United States with the Bodine-Guild sonic hammers and recent work with the Resonance Technology International resonant hammers has shown vibration-free pile driving remains possible.

A Brief History

Sonic technology can be traced back to England in 1913, when Theory of Sonics, authored by Romanian George Constantinesco, was published by the British Admiralty. In the 1930s, fellow Romanian engineer Ion Basgan applied sonic vibrations to the drill pipe string of a conventional drilling rig. The result was improved drilling depth, speed and verticality without distortion, which was a challenge in those days with the methods available. Bore holes using the sonic method were drilled at the Moreni oil fields of Romania in 1938. Basgan filed patents on the technology in Romania and the United States. Success in Romania led to interest in developing sonic drilling in the U.S. during the 1940s and 1950s. Concurrent developments aimed at using vibrations to drill holes were conducted in Russia in the 1930s and 1940s. The initial goal was to speed up oil well drilling operations and most of the research was financed by the petroleum industry. In 1949, Russian professor D.D. Barkan of the Scientific Research Institute for Footings and Foundations reported on research conducted on rotary-vibratory (sonic) drilling techniques. He proposed the use of sonic vibrations in sinking geological exploratory drill holes. At a meeting in 1957 at the Moscow Drilling Institute, drilling rates of three to 20 times faster than conventional methods were reported.

The American program was initially conducted by Drilling Research Incorporated (DRI), which was in operation from 1948 to 1959. It developed a magnetostrictive-rotary-vibratory drilling system. This method was not successful but it demonstrated that vibrations could substantially speed up rotary drilling rates. During this early period, Al Bodine worked with Borg Warner on a down-hole vibrator, which he called a sonic drill. The machine operated using rotating eccentric masses driven by drilling fluid. Using eccentric masses produces force as a function of the square of the operating frequency. Thus, increasing frequency from 50 Hz to 100Hz results in a four-times increase in peak force and accelerations. The down hole drill operated with incredible production rates, unseen in the drilling industry at that time. It failed, however, because excessive vibratory energy caused mechanical failure of the down-hole components. This occurred when resonance of the internal drill components caused runaway or "galloping" amplitudes and accelerations. In the early 1960s, Bodine developed a much larger top-hole vibrator. The machine's intended use was for oil well service work such as pulling stuck casing and rehabilitating oil wells. Bodine received many patents in the 1960s for his work with "orboresonace" drives.

The Bodine Sonic Hammer featuring twin Sherman Tank Engines

In the 1960s, Bodine redirected efforts towards the development of a sonic pile driver. He engineered large vibrators with capacities between 500 and 1,000 Hp but they suffered from poor reliability. Continued effort with the assistance of Charlie Guild of Guild Construction in Rhode Island, and later with support of the Shell Oil Company, improved both the performance of the equipment and understanding of its application. The larger vibrators worked successfully on many projects, posting impressive production rates. These projects included the BART, Harvard University Museum Building and Merritt Island, Mass. At this time, a young physics graduate from Berkeley, Calif., Alan Bies, joined the Bodine team. He witnessed the success of the equipment and understood the theory of resonance intimately. It became Bies's opinion that while the principle of using resonance was sound, the driving mechanism being applied (eccentric mass) was ill-suited to driving a resonant system in a controlled manner. Bies later left the company and became a world-renowned professor of acoustics in Australia.

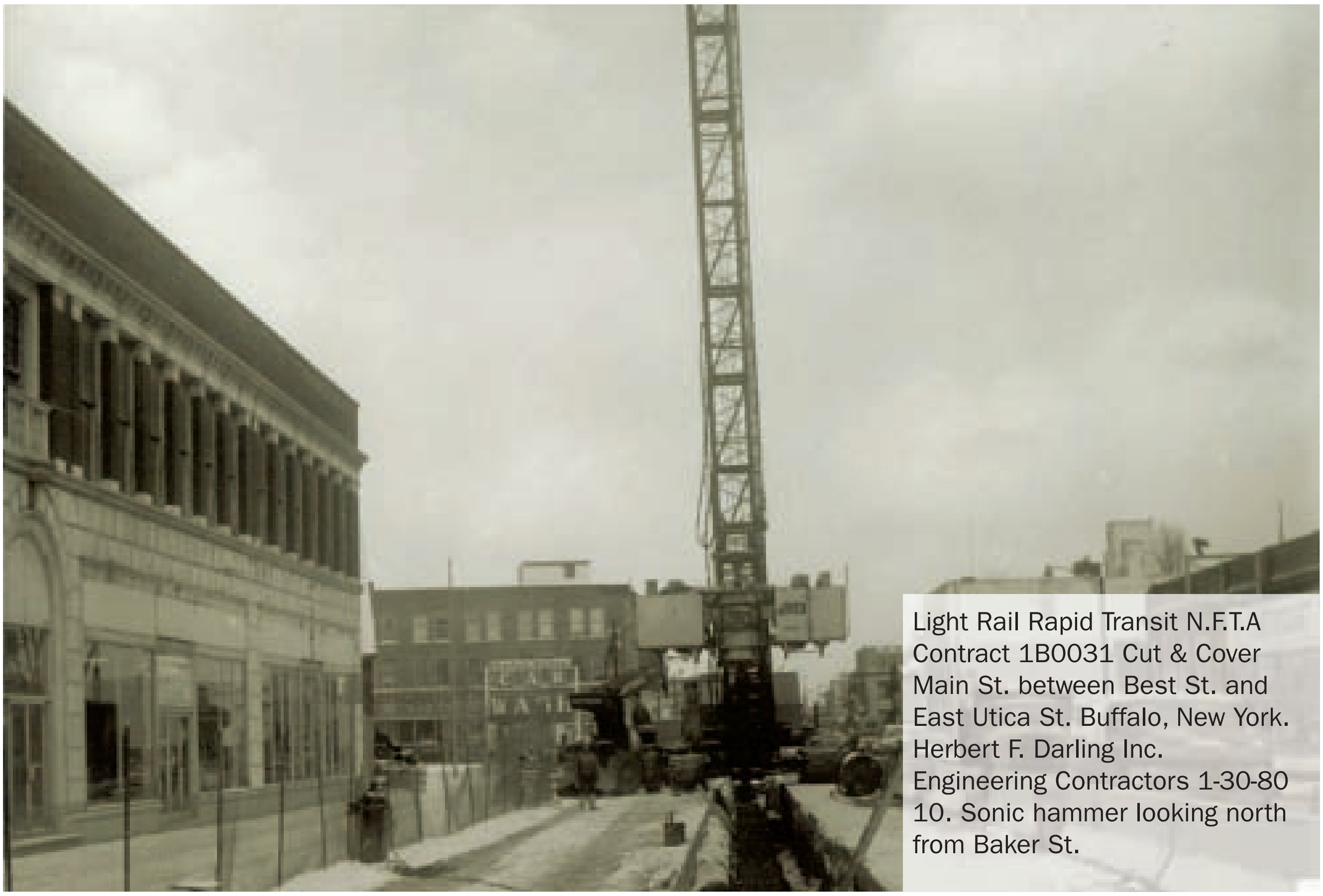
Though the Bodine hammers were called "sonic", they were, in fact, taking advantage of the concept of resonance. Resonance is achieved in many mechanical systems such as pushing a child on a swing or shattering a wine glass with a tuning fork. The vibrator simply supplies vibration power in tune with the natural frequency of the pile for maximum energy efficiency with no energy wasted in the re-mobilization of the pile. The pile stores the energy elastically as a spring, expanding and contracting at its natural frequency. The reader is familiar with the propagation of a stress wave in a pile during impact driving. The impact impulse travels down the pile as a compression wave and reflects from the toe back to the surface as a tension wave. This wave reflection occurs over a time that is the natural period (frequency = 1 period) of the pile. To achieve resonance, the push and pull cycle of the sonic vibrator must coincide with the input and reflected stress waves. The sonic vibrator must apply a downward compression force that creates a traveling stress pulse down the pile. When the pulse reflects upward to the pile top as a tensile stress wave, the sonic vibrator applies a tension, or pull cycle, thus amplifying the existing stress and amplitude in the pile. By pushing and pulling at one end of the pile, the sonic vibrator is able to set up a standing wave pattern in the pile. Effectively, the pile becomes a flywheel into which the resonant energy is delivered. Within just a few cycles, the pile develops substantial amplitude and acceleration. The trick is to maintain the natural frequency of the vibrator with the changing natural frequency of the pile as it is driven into the ground. Once resonating, the pile uses the built-up energy to penetrate the soil at high acceleration and, thus, reduces energy loss to the ground. A common problem with resonance occurs when the stored energy builds up out of control. Larger and larger amplitudes of vibration and stresses within the pile cause failure, either of the pile or the mechanism attached to it.

In the early 1970s, Bodine's group started to develop a smaller oscillator when his equipment was sold to Hawker Siddeley, a well-known British aircraft manufacturer that founded the Sound Dynamics department to manufacture a line of vibratory equipment. The goal was to eventually market machinery based on vibratory technology for various applications such as civil construction. The original research was targeted at developing a large vibrator capable of developing resonance in a foundation pile. The thought was that such a machine could be used to drive the piling for the proposed Alyeska pipeline project (1975-77). Numerous attempts to produce large (750 to 1,000 Hp) rigs failed due to reliability issues. Throughout the Hawker Siddeley years, Charlie Guild continued to work with and develop

Light Rail Rapid Transit N.F.T.A
Contract 1B0031 Cut & Cover
Main St. between Best St. and
East Utica St. Buffalo, New York.
Herbert F. Darling Inc.
Engineering Contractors 7-21-80
13. Repairing of sonic hammer.

the technology for production pile driving. Numerous test drives were conducted on sites and many successful projects were completed, though reliability issues continued to plague the eccentric drives. Data was gathered on the capacity of sonically driven piles and on ground vibrations during sonic driving. The results indicated that sonically driven piles met or exceeded the capacity of piles driven using conventional air-steam hammers while taking only a fraction of the driving time. Comparative pile load tests were conducted at the Harvard Geochemistry Building and the Agassiz University Museum in Boston, Interstate Route 95 (Contract 6172) in Providence, R.I. and the NE Telegraph Co. in Boston, Mass. The absence of ground-borne vibration was documented at the Federal Building in New York City, Niagara Frontier Light Rail Rapid Transit in Buffalo, N.Y. and Dundas St. Sewer Separation Contract in London, Ontario. These test programs established the sonic technique could drive piles to an equivalent capacity as driven piles, dramatically increase production rates and produce negligible ground vibrations which would not disturb neighboring structures.

Unfortunately, the continued mechanical problems that plagued the larger sonic hammers led to their fall from favor in the piling industry. Their downfall lay in the bearing technology required to support both the vibrating shaft that housed the eccentric weights and the drive shaft. The extreme rotating speeds combined with very high loads were too much for



Light Rail Rapid Transit N.F.T.A
Contract 1B0031 Cut & Cover
Main St. between Best St. and
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Herbert F. Darling Inc.
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10. Sonic hammer looking north
from Baker St.

bearing technology available even today.

As part of its research, Hawker Siddeley developed smaller vibrators that could be used for drilling purposes. The machine proved successful in many oil, gas and gold exploration applications. A number of rigs were constructed and sold for these applications. The early rotary-vibratory drills, or sonic drills as they were called, were not configured specifically as drill heads. They were basically oscillators that were modified for drilling and proved to be very unreliable and prone to frequent breakdowns. The earlier sonic drills used available standard drill tooling which was not designed to take the high-frequency vibratory loads imposed by the sonic drill. The result was frequent breakage of drill tools. Nonetheless, the rotary-vibratory technique demonstrated that it had great potential in the drilling industry. It was discovered during early experimentation that, in addition to being capable of drilling holes fast, the machine had an outstanding ability to take truly representative continuous cores of almost any overburden material. It was also able to core through boulders and into bedrock.

The severe recession of the early 1980s discouraged Hawker Siddeley from continuing development work on sonic drill technology. One of the engineers from the Hawker Siddeley team, Ray Roussy, continued to develop the technology specifically for small diameter drilling (<250 mm or 10"). He believed that sonic drilling would become the method of choice for most shallow earth drilling applications. For example, he had seen that one sonic drill could do as much drilling and sampling as three or four auger drills during the same time period. A number of companies began using these specialty rigs and the equipment continued to develop and solve the mechanical problems.

In the early 1990s, Boart Longyear in Salt Lake City, Utah, one of the world's largest drilling contractors, became interested in the potential of sonic drilling technology. Boart expanded into the environmental drilling sector with great success and became a leader in the environmental drilling business with its fleet of almost 180 sonic drill rigs worldwide.

Sonic frequency technology has numerous advantages for environmental sampling. The high accelerations successfully cut the soils with minimal disturbance which provides clean un-smeared sampling from one layer to the next, a very important feature when sampling for trace amounts of contaminants. The method can create a hole with little to no introduction of water or air and, thus, low spoil, reducing the potential for topside wastes. Finally, the method has proven successful in all ground types with very high production. Roussy's Sonic Drill

Corp. continues to develop this now reliable small-scale technology and sell it throughout the world.

Today

Based upon the early success of sonic drill technology and the proof of concept successes in pile driving, Bies continued to tinker with ideas and concepts that would meet the needs of the application. Recent progress with an entirely new mechanism has led to success in driving piles with high-frequency vibration. The new resonant driver is novel in a number of ways. The mechanism does not use eccentric masses, but instead a piston and cylinder arrangement with a unique valve. Thus, the downfall of the Bodine hammers: the vibrating shaft bearings, are eliminated. The new technology is able to excite a pile at its resonant (or natural) frequency to produce elevated levels of acceleration and force, however, the mechanism inherently limits peak displacement and will not suffer from runaway acceleration and force. Direct comparisons between conventional vibrators and impact hammers indicate the resonant driver produces less than 1/100 the vibration. The resonant driver results in ground vibration of between 1/20 and 1/50 of common limit levels (1 cm/s or 0.5 in/sec) as close as one pile diameter.

The resonant driver uses a piston – cylinder mechanism to deliver force to the pile through a specialized clamp. The driver uses a proprietary algorithm to maintain constant tuning of the driver frequency to the resonant frequency of the pile and ground. As the pile penetrates the ground, the resonant frequency of the system changes. Without constant adjustment and tuning, the driver would apply the energy in contrast to the resonant frequency and at increasing lower efficiency with resulting stalling of the pile in the ground.

The use of a piston cylinder arrangement, with a nimble valve geometry, allows for rapid tuning of the frequency independent of hydraulic fluid flow. In addition, the driver may be started at any frequency, thus eliminating the "run up and run down" through all frequencies with conventional equipment that can shake the base machine or surrounding buildings. The hydraulic fluid flow rate defines the amplitude of vibration, and the pressure defines the force of vibration. The design is very simple and uses significantly fewer moving parts than conventional rotating shaft vibratory equipment. The only moving part subjected to high vibrational forces is the simple external cylinder. There are no bearings that experience high levels of vibration. In addition, the simple geometry of the mechanism allows for rotation of the pile while vibrating.

An important feature of the independent control over the force and amplitude of vibration is that it allows use for a large driver with the smallest of piles. Typically, large hammers can only operate on large piles that have sufficient mass and cross-sectional area to prevent damage. The large hammers cannot be "turned down" to operate on smaller piles. A large resonant driver can accommodate even micro or pin piles because the flow rate can be easily reduced to limit amplitude and the pressures are a function of the resistance of the system. Thus, a small pile with limited resistance during installation will draw only enough pressure to advance the pile.

Increasing experience using the resonant driver is creating a database of various pile sections, soil types and achieved

The 140 kW (200Hp) Resonant Driver mounted on a 600 mm diameter pipe pile

capacities. Early results indicate the resonant pile driver may be used alongside existing impact and vibratory equipment for many applications while eliminating ground vibration and maintaining site production.

Demonstrations

At recent test sites, 140 kW (200 Hp) and 260 kW (351 Hp) resonant pile drivers have been used to drive 310 mm HP piles and pipe between 300 and 800 mm with mass of up to 276 kg/m. The HP piles drove well into soils of varying density due to the pile's low cross-sectional area. Smaller pipe piles also drove well, while the larger diameters had a tendency to form plugs and stall at depths of up to 15 m. In comparison to conventional hammers, both impact and vibratory, the resonant

The RD260 Resonant Driver driving a 914 mm dia pipe pile.

pile driver has performed well. What remains significant is the absence of measured ground-borne vibration during driving using the resonant driver.

Piles were driven within the Fraser River Pile and Dredge Ltd. yard on the north bank of the North Arm of the Fraser River within the geography of the Fraser River Delta in New Westminster, British Columbia. The soils consist of dense alluvium over glacial tills. The site consists of three meters of coarse granular materials that contain many inclusions of timbers, steel, cobbles and boulders over native glacio alluvial soils. The native soils are typically dense to very dense sands and gravels with cobble sizes. The water table varies with the tidal influence of the Fraser River at about three to five meters in depth below the surface.

Geotechnical investigation was conducted via exploratory drilling at the proposed location of the test piling. The SPT counts within the upper three meters were obfuscated by the presence of timbers and cobble sizes, but were generally in the 10 to 20 range per 300 mm. Below 4 meters, the SPT blow counts are estimated to be in the range of 50 to 80 blows per 300 mm to depth of 14 m. Within the very dense glacial tills, below 14 m the blow counts are estimated to be >100 per 300 mm.

Two piles were selected for driving using the resonant driver; a 19.8 m long HP 310 x 74 kg HP (HP 12 x 53) section with a mass of 1,480 kg and a 17.8 m long 300 mm diameter pipe pile with a 22 mm wall and a total mass of 2,668 kg. The HP pile was driven to a depth of 12.5 m (41 ft), over a period of approximately 19 minutes. The pipe pile was driven to a penetration of over nine meters over a period of approximately 14 minutes. Each pile was monitored for vibration using conventional Blast-mates (SSU 2000DK Seismograph and noise monitoring station by Geosonics) and high-precision vibration monitoring sensors. The sensitivity of the equipment is set for peak velocities that exceed 50 to 60 cm/s with a minimum trigger threshold of 0.5 mm/s.

The resonant driver did not produce enough ground vibration to trigger the devices so they were manually triggered for each event by tapping the triaxial meter by hand. The recorded velocity waveforms indicate the maximum ground velocity when driving into dense soils is on the order of 0.5 mm/s at a distance of 5 m from the pile. This represents one-twentieth of the acceptable ground vibration levels for work in urban areas in North America. The data further indicates the vertical component of the ground velocity is less than the transverse and longitudinal components.

In comparison, an 18 m long HP 310 x 74 pile was driven to a depth of 6.3 m using a 1,640 kg (3,600 lb.) drop hammer. Drop heights ranged between 2.5 m to 3 m, or 48kNm (36,000 ft/lb) at the end of driving. Blows varied from 5 to 20 / 300 mm in the upper 2.5 m and increased from 35 to 60 bl / 300 with depth to 6.3 m penetration. The time required to drive the pile was approximately 1 hour, 8 minutes. An ICE 216 vibrator was used to drive a 11.9 m (39 ft) long HP 310 x 74 (HP 12 x 53) pile. The pile was driven to a maximum depth of approximately 2.5 m to 3.0 m at four locations, but was unable to penetrate the dense gravels and cobbles despite driving times in excess of 10 to 15 minutes. At a later date, a MKT - V17, 250 kWatt (335 Hp) conventional vibrator was used to drive a pile in direct comparison to the resonant driver. The MKT hammer drove a 11.9 m (39 ft) long HP 310 x 74 (HP 12 x 53) pile to refusal at a depth of 11.3 m. The total driving time for the pile was on the order of 10 to 11 minutes. During the driving of the pile, a large depression 1.2 m (4 ft) across was formed around the pile at the stabbing point and ground vibration of 1.5 to 2 cm/s were documented three meters from the pile.

At a nearby production site, piles of 500 mm, 600 mm and 750 mm diameter were driven as part of an environmental control structure. The site is within the outer region of the Fraser River Delta with soils consisting of loose to compact sands and silts, increasing from dense to very dense sands and silts with depth. The site is typical of a deltaic environment with deep deposits of layered silts and sands. The area has been filled within the upper 1 m with wood chip materials to provide a working platform. The native soils below are typically loose to compact silts and sands, increasing density at 6 m and increasingly dense with depth. Soil SPT counts increase with depth ranging from 2 to 10 bl / 300 mm at the surface, 18-30 bl at 6 m depth and 50 to 60 bl at 18 m depth. The water table varies with the tidal influence of the Fraser River at about 2.5 to 5 m in depth below the surface.

At this site, production pipe piles 750 mm diameter x 16 mm wall were driven using an APE 200 470 kW (630 Hp) conventional vibratory hammer to a penetration depth of 7.5 m. A 3,200 kg drop hammer with 47-113 kNm peak energy was used to drive open-ended 500 mm and closed-ended 600 mm diameter x 12 mm wall pipe piles. The resonant pile driver was used to drive two pile sizes at the site: an HP 310 x 74 section 19.8 m in length and a 400 mm dia x 12 mm wall pipe pile 23.85 m in length. The HP pile was driven to full depth of approximately 19 m and the 400 mm diameter pipe pile to a depth of 10.4 m. The HP pile drove to full depth in 12 minutes at a maximum flow rate of 4.5 l/s and an operated pressure 14 MPa for total driving power of 52 kW (70Hp). The 400 mm diameter pipe pile plug was measured to be 5.47 m from ground level. The 400 mm diameter pipe pile was driven at a maximum of 17 MPa at 5.0 l/s for a peak driving power of 72 kW (95Hp). In each case, the piles were driven using the automated electronic frequency tuning system, which optimized the driving frequency at the resonant frequency of the pile-soil system.

Vibration monitoring was conducted using three Dytran Instruments single axis accelerometers including two model 3191A1 (10 V/g) and one model 3192A (1V/g). The data acquisition system used included a 1 MHz A/D board integrated with a Toshiba PC. This permitted readings of ground acceleration on each channel at a rate of 1000 Hz. Measurements were made during driving of the 750 mm diameter open-ended pipe pile using the APE 200 and a 500 mm diameter closed-end pipe pile using a drop hammer with up to 113 kNm of impact energy. The data indicates that the vertical ground vibration levels are over 1.75 m/s2 at a 10 m distance for the vibratory driven pile and well above 8 m/s2 at a 10 m distance for the impact driven pile. At 30 m from the source, the vertical ground accelerations are on the order of 0.4 m/s2 for the vibratory driven pile and 1 m/s2 for the impact driven pile. Vibration monitoring during resonant driving indicated the typical accelerations at 10 m are on the order of 0.25 to 0.3 m/s2. The acceleration histories appear to show little change in the ground motion with pile penetration at the 10 m and 30 m locations.

In late 2008, a 260 kW Resonant Driver was used to drive pipe piles and HP section into dense sands and silts. The hammer drove piles up to 600 mm in diameter to depths of 14 m to 15 m into very dense (>100 bl / 300 mm) sands. Driving times ranges between eight and 15 minutes for the resonant driver. Ground vibrations were measured and recorded at less than 1/10 of allowable levels at a distance of 7.5 m. The same piles were driven by a 480 Hp high-frequency vibratory hammer to similar depths in similar times. The ground vibrations during driving with the conventional hammer exceeded allowable levels by a factor of 1.5.

Conclusion

The precedence set by the Bodine Sonic Drivers in the early 1960s for rapid production with minimal ground disturbance is being relived today with new high-frequency technology. The new resonant driver based upon a piston and cylinder mechanism is able to resonate a pile and advance it rapidly into the ground while causing near negligible ground vibrations, thus, will safely drive piles adjacent to sensitive structures. More work is needed and access to production pile driving sites is required to improve the database of pile and soil types that are appropriate for the use of the resonant pile driving method. ▼

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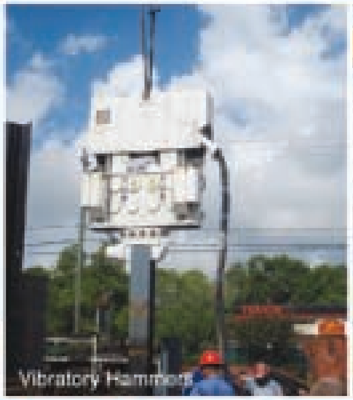

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New Technologies in Pile Driving

By M. Justason, P.Eng., Bermingham Foundation Solutions

This article highlights some of the most notable advances in driven pile technology over the last decade. Specific topics include the use of pile foundations for heating and cooling, advances in quality assurance and quality control, and new developments in testing and installation equipment. New strategies for dealing with environmental concerns such as noise and vibration are also discussed, including a new concept referred to as "intelligent pile-driving" whereby the hammer energy can be automatically controlled based on measured sound, vibration, and pile stresses. Other new technologies and trends in piling equipment are also discussed.

Use of Driven Piles for Heating and Cooling

A relatively new addition to the list of advantages of driven piles is their potential use as part of a geothermal heating and cooling system. The features of geothermal systems are generally well known, but what is not is that pile foundations can be key to constructing a cost-effective system.

In fact, under the right circumstances, a building's pile foundations can provide 100 percent of that building's heating and cooling needs. Using the pile foundations as the interface with the ground greatly reduces the payback period for the geothermal system. These types of systems have been in use in Central and Western Europe for more than 20 years, but have only recently appeared in North America. Circulating pipes for the geothermal system can be pre-installed in either precast concrete piles or installed after driving in closed-end pipe piles. These types of piles are sometimes called absorber piles or energy piles.

Piling Equipment

Over the past decade, driven pile equipment in North America has shown a strong European influence. The main shift has been towards hydraulic hammers and away from diesel and air hammers. The main attractions of the hydraulic hammer are improved controllability and performance monitoring. Most European-made hydraulic hammers introduced to North America in the past decade have performance monitoring built-in to the hydraulic power unit that runs the hammer, or the foundation rig that the hammer is mounted on. This monitoring system allows engineers to verify that the hammer is producing the required amount of impact energy. Also, unlike a diesel hammer, the energy (or stroke) of a hydraulic hammer can be controlled independently of the pile and soil resistance.

This improved controllability is thought to provide an

advantage when driving concrete piles that are prone to break in tension if struck too hard. With increasing steel costs and a greater shift to concrete piles, combined with improved systems for splicing concrete piles, hydraulic hammers have captured significant market share in the past decade.

Some factors that have kept the diesel hammer alive and well in North America have been advances in the use of biofuels and oils, as well as cleaner-burning diesel hammers and diesel hammers with built-in performance monitoring (discussed below). Of course, the biggest factor effecting a contractor's choice of hammer is the capital cost, and the shift to low-cost Chinese-made diesel hammers has been widespread.

Sound mitigation remains the driven pile's main area for improvement and several hammer manufacturers have taken up the challenge. Some hammer manufacturers have developed very effective sound enclosures for their hammers that can greatly reduce the measured sound levels. Look for this topic to appear in future developments in driven pile equipment.

Another new development in piling equipment has been the introduction of dedicated piling rigs and the increased popularity of fixed-lead systems. These developments can improve the locating and leveling functions during pile installation. In a related development, the use of GPS or other land-based positioning systems for locating foundations has entered the market. Sensors on the booms of cranes, masts of foundation rigs, or the tops of leads have now been used to assist in the positioning of driven piles. In its simplest form, this advancement allows the crane or rig operator to position the foundation according to the specified coordinates thereby minimizing cost of survey staking and the inevitable re-staking. In some cases, such as in marine pile driving, this new feature can even eliminate the need for a costly positioning template. Lead and pile positioning systems are sure to gain popularity over the next few years, with some systems even promising to automate the positioning process.

The penetration of dedicated foundation rigs into the North American market has not gone unnoticed by crane manufacturers. Several large crane manufactures have developed what are called duty-cycle cranes that are better suited to foundation applications. Some crane manufacturers have always had these cranes while others have designed new crane models geared specifically toward the foundation market. The European-style foundation rigs have a very strong presence in the drilling market, but in the overall foundation market, crane-mounted foundation equipment still holds the largest market share in North America.

New Tools for Quality

Probably the most significant changes to the way piles are driven over the past 10 years have come in the area of the monitoring equipment. Dynamic pile testing methods are now universally accepted. Using this method, pile capacity can be estimated and driving stresses measured. This equipment has greatly improved the quality assurance of the driven pile, and is now available with wireless and even remote operation. Even when dynamic testing is not performed, new tools such as acoustic blow counters and hammer energy monitors (described below) all serve to improve the overall quality of the driven pile. New developments using embedded strain gauges and accelerometers in concrete piles that transmit wireless signals to data-collection devices using BluetoothTM technology are already in use in some states.

In pile driving, QA and QC typically consist of pile installation records that log the number of blows per unit of penetration, and the final tip elevation for each pile. Very often, however, the performance of the pile hammer is not logged on the pile installation record, or more disturbing, the pile hammer may appear to be operating at the desired impact energy, while in fact it is not. This can lead to a potentially dangerous situation, whereby piles are believed to have more capacity than they actually do.

Verifying hammer performance is now possible using an instrumentation port that allows for monitoring the impact velocity of the ram using magnetic proximity switches. Typically, two proximity switches located on the body of the hammer sense the position of a particular machined feature of the ram. Knowing the distance between these two proximity switches and the difference in time between switching signals, the velocity of the ram just prior to impact can be calculated. Further development of the velocity monitoring system included the addition of other features for greater QA and QC in pile driving. In 1990, a device called a pile driving monitor (PDM) was introduced, It included a depth logger and blow counter, and calculated impact energy, pile number, cut-off elevation, date, time, project name, splice location, and various other pertinent information.

Early versions of these energy monitoring devices included on-board printers for record-keeping, but these have been replaced with newer PDMs that include USB ports for connection to a computer or direct connection to a USB memory key for downloading of data.

Another innovation used to improve the QA and QC for pile driving was an acoustic blow counter called the SaximeterTM. This device "listens" to the blow rate of a hammer, and using a basic formula, estimates the stroke, or the potential energy of a hammer (not to be confused with the impact or kinetic energy). It also offers the ability to record blow counts and to store other pertinent QA and QC information. While the original versions of this device offered no ability to detect impact velocity, there is a newer version of the device that uses proximity switches, very similar to the PDM that allows it to monitor impact velocity. This device is called the E-SaximeterTM.

Any discussion on new technologies for quality assurance in piling would be incomplete without mentioning rapid-load testing. This type of testing has become more popular in the past decade as it has gained more widespread acceptance.

Advances in Vibratory Hammers

Like drills, vibratory pile-driving hammers have also increased in size. While the specifications of some of the newer, larger hammers are impressive, more notable is the advent of a new type of vibratory hammer called a variable-eccentric moment hammer. This new type of vibratory hammer allows the driving amplitude of the hammer to be adjusted independently of the rotational speed of the eccentric masses inside the hammer. This means the hammer can be started and stopped without passing through any resonant frequencies of the crane boom that typically produces a short occurrence of violent shaking.

More importantly, because these new types of vibratory hammers can control their amplitude and frequency, they can control the amount of vibrations felt at adjacent structures. These new variable-moment hammers have extended the use of vibratory hammers into areas where normal vibratory hammers would have been forbidden. In addition to variable-eccentric-moments, more and more high-frequency hammers are appearing in the market. These hammers operate at more than double the frequency of standard hammers that can also reduce the magnitude of vibrations in the adjacent soil and structures.

Another area to watch in the development of vibratory hammers is the advent of a new resonant-frequency vibratory hammer. While not on the market yet, there is a good chance this new technology will start appearing in the next few years.

Intelligent Pile Driving

Developments on the horizon for driven piles include "intelligent" pile driving, whereby the hammer energy is controlled in real time by any number of measured variables such as measured vibration, measured sound levels coming from dynamic testing equipment, including pile stress (tension or compression) or required capacity. Prototypes exist for this type of system and should be on the market within the next few years.

Impact hammers are not the only tools with so-called "intelligent" control systems. Already on the market are systems that provide automatic frequency control for some variable-eccentric-moment vibratory hammers. These automated systems have the ability to adjust the frequency of the vibratory hammer in real time to maintain vibration levels below a preset limit, as measured at a control location.

Summary

Overall, the advances in piling technology in the past decade have been significant. Unfortunately, most of the technological advances described in this article are slow to be adopted. Most of the new technologies discussed in this article do not have significant market penetration. On a daily basis, contractors, owners and engineers struggle to solve installation, or quality problems that can easily be solved by using new technologies. This highlights the importance of continued education programs and reinforces the mandate of industry organizations such as the PDCA to disseminate information to its members and the industry at large. ▼

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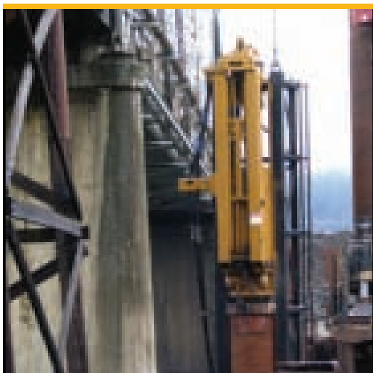


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The world's largest single gearbox vibro, the APE Model 600 with the patented Quad Clamp System is designed for the hard jobs and matched by no other in the industry.

APE's high quality, competative priced, single acting deisel hammers are re-defining the foundation industry proving that PEAK FORCE matters on steel piles.

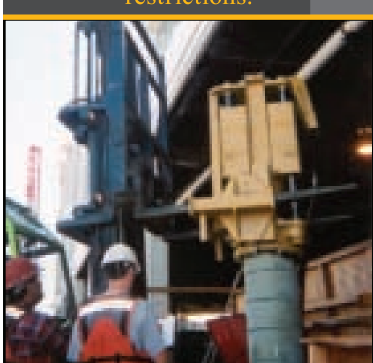
***The Largest Manufacturer of Foundation Equipment in the World.**
***Engineering Designed to Solve problems at the Pace of the industry.**
***Largest Rental Fleet in the Foundation Construction Equipment Business.**
***Greatest Number of Patents in the Industry to Protect Your Investments.**
***Leading the Way in Innovation and Special Applications Increase Your Profits.**
***We Make You Our Number One Priority.**

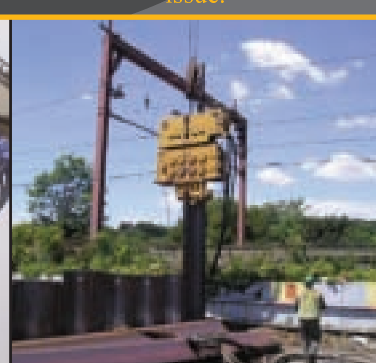
APE's line of low headroom hydraulic hammers, created to solve seismic retrofit issues, reduce the number of splices needed for extreme overhead restrictions.

J&M Robovib excavator mounted pile driver allows one operator to do the work of three while *minimizing downtime and increasing productivity*

APE's Model 250 Variable Moment Vibro is the answer to the contractor's search for a *reliable, rugged* tool to use when radial vibration is an issue.

The Model 750 hydraulic impact hammer, with its 120,000 lb ram, is the *largest* American-made hydraulic impact hammer ever built.



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