PILEDRIVER

The Official Publication of The Pile Driving Contractors Association | spring 2003 vol. 4, no. 2

IN THIS ISSUE:

DICEP 2003 Conference Program and Registration Information

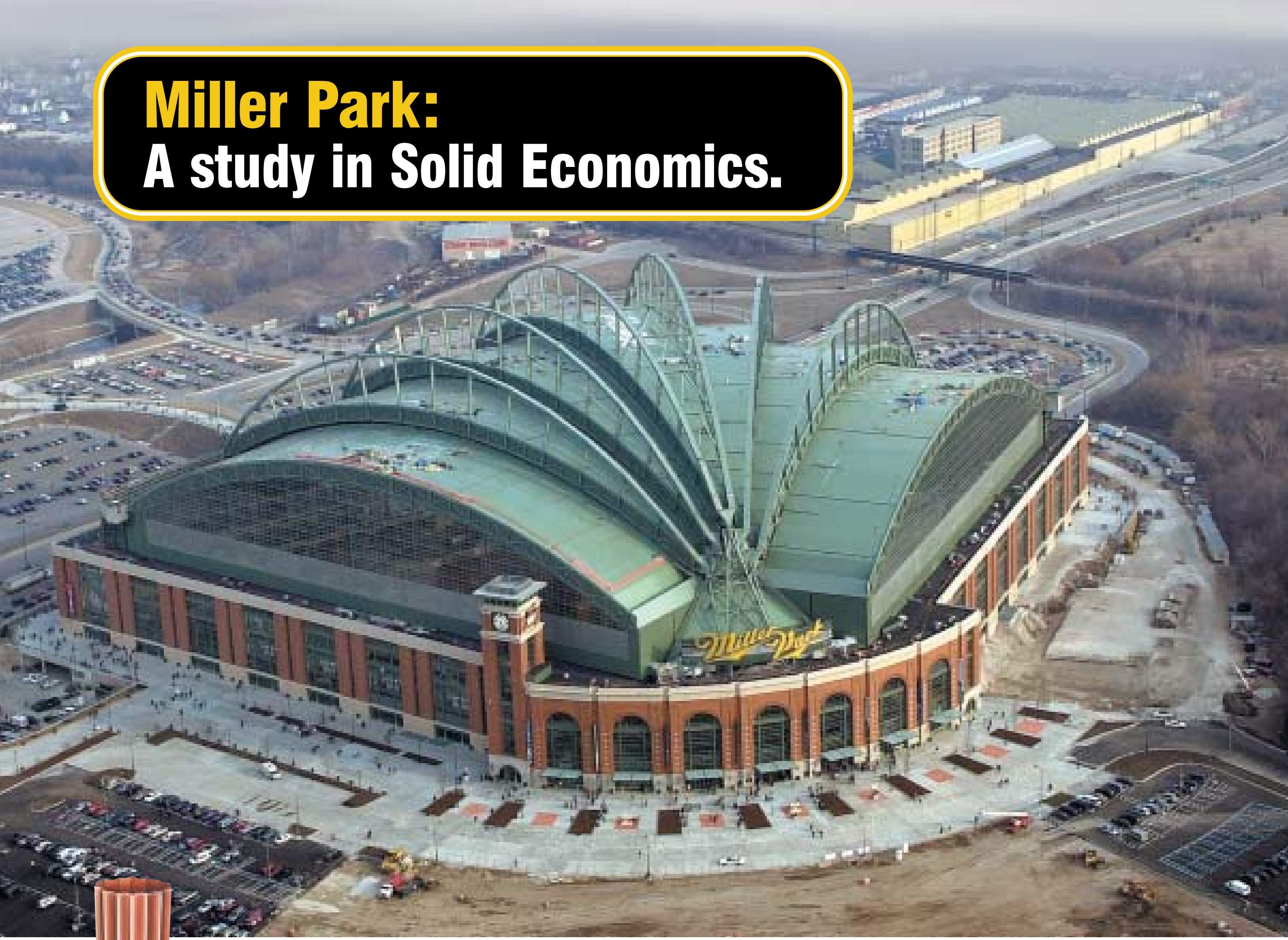
San Mateo-Hayward Bridge Project wins PDCA Project of the Year Award

World War II Memorial

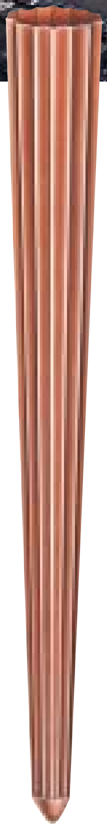
Safety Factors for Pile Testing

PDCA Member Spotlight: Charles Whiteaker

PDCA
PILE DRIVING CONTRACTORS ASSOCIATION



Miller Park:
A study in Solid Economics.



Monotube® Piles saved millions in its deep foundation work.

This uniquely designed stadium represents a significant long-term investment for the greater Milwaukee region. Getting it done on budget meant looking at every cost alternative. Geotechnical engineers recommended designing and implementing a test pile program to determine the most cost-effective deep foundation pile system. Two types were selected to be tested: straight, parallel-sided steel pipe and our uniformly-tapered steel Monotube® piles.

Their summary showed the Monotube® piles to be the most economical by far. Examining the results on an ***installed cost-per-ton supported***, data showed the Monotube® achieved a 400-ton ultimate capacity at the 77-ft. range. The pipe, by comparison, required over 100-ft. embedment to obtain a 300-ton ultimate capacity. Using conventional equipment, Monotube® piles required significantly less time and hammer blows to penetrate to final design depth, thus achieving design capacity with much shorter embedment lengths.

Importantly, it was recognized that by investing a relatively small amount of money in a test pile program early on, millions could be saved in the deep foundation work designated for driven piling.

Similar levels of savings have been repeated time and again over our 70-plus years in the industry. Your heavy projects could benefit equally. Call for our free test data brochure – it's a fresh look at solid economics.

MONOTUBE® PILE CORPORATION

P.O. Box 7339 • Canton, OH 44705-0339 / Ph. 330.454.6111 • Fax 330.454.1572
Email: monotube@raex.com / www.monotube.com

MONOTUBE IS AFFILIATED WITH DAVIDSON PIPE SUPPLY CO., INC.

PILE DRIVING CONTRACTORS ASSOCIATION
P.O. Box 19527
Boulder, CO 80308-2527
Tel: (303) 517-0421
Fax: (303) 443-3871
www.piledrivers.org
Email: membership@piledrivers.org

Published by:
Lester Publications
2131 N.W. 40th Terrace - Suite A
Gainesville, FL 32605

Vice President
David Langstaff | (866) 875-5888

General Manager
Michael Winters | (877) 387-2700

Managing Editor
Lisa Kopochinski | (800) 481-0265

Design Production Manager
Jennifer Karton | (877) 953-2587

Advertising Representatives
Debbie Angers, Ron Ciecko, Louise Peterson, Jason Stefanik, Victor Wallack, Al Wiebe.

Visit the PDCA Web site at www.piledrivers.org.

For reprint information, contact Lisa Kopochinski, editor, at (800) 481-0265.
For a media kit, visit www.piledrivers.org.

Piledriver is published quarterly.
Please contact us by mail at P. O. Box 19527, Boulder, CO 80308-2527
Phone: 303-517-0421 | Fax: 303-443-3871
or by E-mail at membership@piledrivers.org.

The subscription rate for members is $18 which is included in the annual dues. The U.S. subscription rate for non-members is $36 for one year and $72 for two years.

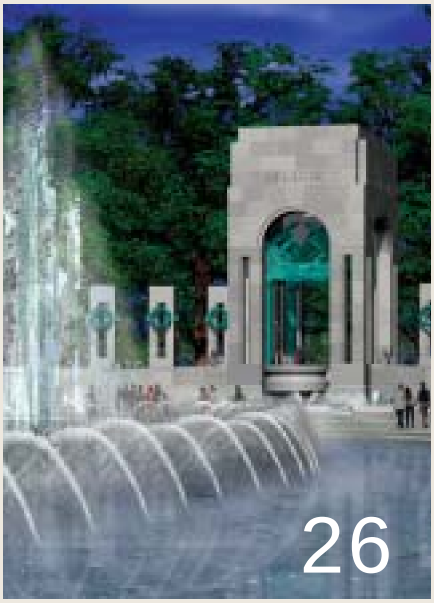
Canadian subscribers: add $5 per year. All other non-U.S. subscribers add $10 per year.

PILEDRIVER

THE OFFICIAL PUBLICATION OF THE PILE DRIVING CONTRACTORS ASSOCIATION | SPRING 2003 VOL. 4, NO. 2

Contents

9



26

Advantages of the Driven Pile

By Jim Frazier, PDCA President

The driven pile is really the high-tech, deep foundation solution. It seems that designers have not considered all of the advantages that accrue to a driven pile deep foundation.

First, consider our knowledge of the pile material. Before we begin to drive, we know the material properties. If we are driving steel piles, we know that the material was produced in a factory under tightly controlled conditions. The mill heat reports will be available for inspection by anyone interested. This gives us proveable and traceable knowledge of the steel strength and chemistry.

Concrete piles have also been produced in a plant using well-proven and controlled conditions. Measurements of material strengths are made on a routine basis and the information is available before the pile is driven. Only timber piles are not produced in a factory, but our knowledge of specie characteristics and the inspection of the pile assure us that material meets a standard requirement.

So, we know the quality of the product we put in the ground. However, what about the damage to the pile that might occur during driving? Here we have a driving record. If damage occurs, it will surely be recognizable in the driving record. This gives us a very high confidence level for the material in our installed pile.

But, will the pile successfully transfer the load to the soil? Deep foundations that are not driven rely on a static analysis of the subsurface information to try to predict capacity or they must use a static load test. Again, the driven pile has an advantage. There are methods available for relating observations made during driving to the pile strength. The capacity can be estimated from the driving blow count with a simple formula. While this approach is not very accurate, it has been proven to be much better than the evaluation of the subsurface investigation. As a next step up in accuracy, the blow count can be used in a wave equation analysis to obtain a capacity prediction.

Then, a further increase in accuracy is obtained by making measurements during driving using a Pile Driving Analyzer. These three methods involve some increase in complexity and cost as one moves up the line. But all of these methods give better measures of accuracy than the geotechnical analysis. Of course, a static load test can also be performed.

However, there is still a more important advantage for the driven pile. Since every pile is driven, every pile will penetrate to a common capacity. They will all have a somewhat different penetration due to the soil variability. They will not just be installed to an estimated standard depth. ▼

2003 PDCA Board of Directors & Committee Chairmen

Jim Frazier
President
P: (303) 791-5642
F: (303) 791-5647
C: (303) 419-1543
9002 North Moore Road
Littleton CO 80125

Randy Dietel
Vice President
P: (409) 945-3459
F: (409) 945-4318
P.O. Box 1847
Texas City TX 77592-1847

Wayne E. Waters
Treasurer
P: (904) 268-4419
F: (904) 260-9379
C: (904) 631-8308
6467 Greenland Road
Jacksonville FL 32258

Charlie Ellis
Past President
P: (402) 228-1624
F: (402) 228-1758
801 Clearwater Circle
Beatrice NE 68310

John L. White
Member
P: (253) 872-0141
F: (253) 872-8710
7032 South 196th Street
Kent WA 98032-2185

Harry Robbins
Member
P: (843) 577-0545
F: (843) 577-0547
P.O Box 70986
Charleston SC 29415

Mark Weisz
Member
P: (707) 562-4100
F: (707) 562-4106
P.O. Box 2195
Vallejo CA 94592

Trey Ford
Member
P: (757) 497-3593
F: (757) 497-0031
4985 Euclid Road
Virginia Beach VA 23462

Anthony Will
Member
P: (925) 754-6633
F: (925) 625-5783
P.O. Box 97
Oakley CA 94561

Reginald K.L. Lee
Member
P: (808) 735-3211
F: (808) 735-7413
614 Kapahulu Avenue
Honolulu HI 96815

Garland E. Likins, Jr.
Member
P: (216) 831-6131
F: (216) 831-0916
4535 Renaissance Parkway
Cleveland OH 44128

Rory Kelly
Member
P: (703) 978-2500
F: (703) 978-2908
5610-B Sandy Lewis Dr
Fairfax VA 22032

Stephen K.Whitty, Jr.
Member
P: (985) 643-0690
F: (985) 643-0690
C: (985) 707-7353
P.O. Box 1607
Slidell LA 70459-1607

Tanya Goble
Executive Director
P: (303) 517-0421
F: (303) 443-3871
P.O. Box 19527
Boulder, CO 80308-2527

2003 Committee Chairmen

Van Hogan
Communications Committee
P: (904) 268-4419
F: (904) 260-9379
C: (904) 631-8309
6467 Greenland Road
Jacksonville FL 32258

Wayne E. Waters
Finance Committee
P: (904) 268-4419
F: (904) 260-9379
C: (904) 631-8308
6467 Greenland Road
Jacksonville FL 32258

Mark Weisz
Education Committee
P: (707) 562-4100
F: (707) 562-4106
P.O. Box 2195
Vallejo CA 94592

Michael F. Engestrom
Market Development Committee
P: (954) 384-4545
F: (954) 337-0831
772 Sand Creek Circle
Weston FL 33327

Randy Dietel
Technical Committee
P: (409) 945-3459
F: (409) 945-4318
P.O. Box 1847
Texas City TX 77592-1847

Rory Kelly
Member Services Committee
P: (703) 978-2500
F: (703) 978-2908
5610-B Sandy Lewis Dr
Fairfax VA 22032

PDCA Update

By Tanya Goble, PDCA Executive Director

The PDCA has had a busy and successful year so far and a number of exciting new programs are planned for the rest of this year.

In this issue of *Piledriver*, you can read about the many significant contributions of our committees. A big thank you goes to the PDCA members who have volunteered their time to the association. Their work will help increase market share for driven piles and increase business for everyone in our industry.

Here's a brief summary of some of the things the PDCA will be working on over the next several months:

Our first local chapter is up and running in South Carolina. The South Carolina PDCA, as it will be known, had its first meeting with over 50 contractors and suppliers to the industry in attendance. Harry Robbins of Palmetto Pile Driving is president of the new chapter. The chapter will concentrate on developing business opportunities in South Carolina. The PDCA will be establishing local chapters in other parts of the country soon.

The second annual Professor's Piling Institute will be held in June with another 25 professors expected to attend. By this year, in-depth information on the latest practices in the design and installation of driven piles will have been presented to 50 university professors. In just the next 12 months, we can expect that these 50 professors will have taught a course in deep foundations, with a primary emphasis on the driven pile, to 800 to 1,000 students. Future engineers, who will determine specifications for deep foundation projects, will get much better training on designing constructible and economic driven pile foundations.

In September, the fourth Annual Design and Installation of Cost-Efficient Driven Piles Symposium (DICEP) will be held in Chicago. There will be a number of excellent presentations geared to helping educate the engineering community on best practices for the design of pile foundations. You will find program and registration information in this edition of *Piledriver*.

In addition, we are hard at work developing new programs to address noise and vibration issues and to better market the benefits of driven piles. For the latest on these and all of the PDCA's activities, please visit our Web site at www.piledrivers.org. ▼

PDCA **Committee** Updates

February 20-21, 2003

Technical Committee

The Technical Committee is responsible for developing and updating various technical specifications and publications.

In February, the committee completed work on a proposal to update the AASHTO guidebook on the installation of driven bearing piles. This guidebook is used by all DOTs. The proposed changes will be presented at the annual T-15 AASHTO bridge committee meeting in early June. The updated guidebook will incorporate current pile driving practices and help make future job specifications clearer and more consistent with new developments in the industry.

Next, the committee will begin work on producing a guide specification for the installation of driven bearing piles in the private sector. The objective is to provide a set of well-defined specifications to be used by civil engineering designers. The PDCA would like to complete work on these over the next year. We need example specifications, so if you have ones that you could make available to us, please send them to PDCA at P.O. Box 19527, Boulder, CO 80308-2527. We welcome your comments on what you like or do not like about current specifications.

Education Committee

This committee is responsible for all educational programs run by the association, including the annual Winter Roundtable, Design and Installation of Cost-Effective Piles (DICEP) Conferences and the College Professor's Piling Institute.

The 2nd Annual Professor's Piling Institute will be held June 9-13 at Utah State University in Logan. This key program presents the latest concepts in driven pile design, installation and quality control to 25 geotechnical faculty members that teach foundation engineering courses. The objective is to ensure that material is being presented in the classroom that will result in constructible and economic driven pile foundations. Universities represented this year include Oregon State, Idaho, USC, UCLA, Texas, Wisconsin, Massachusetts, Memphis, UNLV, Missouri, The Citadel, Michigan and the New Jersey Institute of Technology.

The committee also started to define programs for the next Design and Installation of Cost Efficient Piles (DICEP) conference, to be held in Chicago September 18-19, 2003 and the 2004 Winter Roundtable conference, to be held in Orlando February 21-22, 2004. A DICEP program and registration information is provided in this edition of *Piledriver*. Presentations at the 2004 Winter Roundtable will include many topics of interest to PDCA contractor members, such as marine pile driving, rapid construction, use of the remote PDA, software for estimating and project management, lateral loads, private sector building specifications and a discussion of driven piles versus auger-cast.

Market Development Committee

This committee is charged with developing industry data and promotional programs for the driven pile.

THANK YOU!

Please support our advertisers! Without them, this wouldn't be possible.

The committee is presently gathering driven pile literature, reference documents and resource links for the PDCA Web site. The committee is also tracking the I-195 Rhode Island DOT Test Pile Program. PDCA members have donated piling products for this program, which is to determine the best-driven pile type for the project.

Public Relations Committee

This committee will be merged into the Communications Committee in the future, due to the significant overlap of activities between the two committees.

The Public Relations Committee runs the annual PDCA Project of the Year Award. Balfour Beatty won the 2002 award for their work on the San Mateo Bridge. You can read more about it in this edition of *Piledriver*. Look for advertising and entry forms for the 2003 Project of the Year award on the PDCA Web site soon. The award will be presented at the Winter Roundtable in February 2004.

The Public Relations Committee is also completing work on a new CD-ROM learning tool on pile driving that will be made available to university professors and civil engineering students. Finally, the Public Relations Committee is creating a postcard mailing highlighting the benefits of driven piles.

Communications Committee

The Communications Committee has made significant improvements to the Web site and magazine over the last few months to let us better communicate with the PDCA membership. The Web site, www.piledrivers.org, has been completely rewritten for improved functionality and reliability. All PDCA contractor and associate members have now been added to the online database and can be accessed through the Member Search page. Regular updates and additional improvements are planned for the Web site in the future. And as you have probably noticed, we have a new publisher for the quarterly magazine, along with a higher quality look and new name.

Membership Committee

The membership committee is continuing a strong push to grow the PDCA membership base. This spring, American Piledriving Equipment (APE) is offering free PDCA membership with the rental of their equipment. For more information on this program, visit their Web site at www.apevibro.com. The first local chapter of the PDCA, the South Carolina Pile Driving Contractors Association, has recently been started. The chapter will focus on growing market share and business for the driven pile at the grassroots level. For more information, contact Harry Robbins at (843) 577-0545.

PDCA Pile Tips Invitation

The Pile Driving Contractors Association invites members to submit press releases or other notices for publication. Announcements can include information regarding new branch offices, new projects awarded, new hires or promotions, new product lines, etc. Submissions should include factual, rather than promotional, material.

Please email your request and announcement to membership@piledrivers.org.

ABI, Inc. TOLL FREE 1-877-224-3356

The ULTIMATE PILE DRIVING MACHINE

VIBRATION FEATURES PRESSING

50 pair of sheet pile in 1 day

30 I-Beams in 1 day

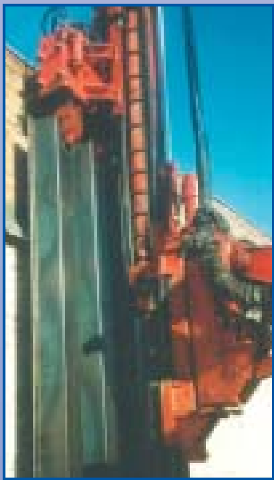
So precise with down crowd that NO TEMPLATE is needed

Pre-drilling over 1500FT/day; swaps to hammer in 5 minutes

Drive next to buildings with variable moment

Sheets so precise that EVERY SHEET is driven to grade

PRESS the sheets in to the ground WITHOUT VIBRATION in urban areas where vibration or noise is a problem



Sheet pressed 2” from a brick wall without any vibration or settlement

SPEED: 4 sheets x 40 feet in 20 minutes

VIBRATING: Sheet Pile, I & H Beams, Cans, Stone Columns, Piles, Soil Improvement
DRILLING: Secant/Tangent Wall Drilling, CFA, Partial & Full Displacement
PUSHING: Hydro-Press System To Push Sheet Piles (Non-Vibration)
www.abi-delmag.com


2003 PDCA Winter Roundtable Conference: **A Great Success!**

The PDCA had a very successful Winter Roundtable Conference. Held February 21-22 at the Sheraton Buckhead Hotel in Atlanta, more than 140 people were in attendance.

Several of the presentations described competitive advantages for driven piles:

- Van Komurka showed how it is possible to use measured setup to design a minimum cost pile foundation.
- Michael Justason of Berminghammer discussed how pile installation costs can be reduced by increasing the number of piles driven per period of time.
- Chris Thompson, of Trow Consulting, discussed how high bearing capacities can be developed by driving steel piles into dense soils.
- A panel discussion highlighted advantages of driven piles such as the ability to use a reduced safety factor and increasing capacity.
- Scott Webster described how the driveability of a pile can be changed by changing its impedance.
- Wayne Waters and George Goble discussed a field demonstration project showing that static analysis methods for predicting pile capacity typically underpredict actual capacity.

There were also some lively discussions on noise and vibration:

- Professor Jim Bay, of Utah State, discussed how piledriving-induced vibrations can be reduced and showed that, in most cases, these vibrations are minimal and do not cause cracking in adjacent structures.
- Sergei Drabkin, of Consuela Engineering, also discussed his work on vibration.
- Rob Van Foeken then presented the IHC Hydrohammer system for controlling noise.
- During a panel discussion on these topics, Reggie Lee of Hawaiian Dredging described how he solved the noise problem in Honolulu.

For a copy of the conference proceedings, please contact the PDCA office at (888) 440-7453. The PDCA thanks all exhibitors, conference sponsors and speakers for their participation. ▼

ROUND TABLE **EXHIBITORS**

ABI
American Piledriving Equipment
Brown-Strauss Steel
CMRM
Crane Products
Dawson Construction Plant LTD
Endurance CSP
Geokon
Gunderboom
Hammer & Steel, Inc.
Hydraulic Power Systems
ICE
JD Fields
Junttan
LB Foster
Liebherr Nenzing Crane
Link-Belt Construction Equipment
Measutronics
Menck GmbH
Monotube Piling
Nucor-Yamato Steel
Penn State Fabricators
Pile Dynamics
Pileco
Pile and Piling Concrete USA
Pittsburg Coatings
Saginaw Pipe
Skyline Steel
Steel Dynamics
Timber Piling Council
Versabite Piling Accessories
Vulcan Foundation Equipment

Platinum Sponsors

American Piledriving Equipment Inc.
Steel Dynamics Inc.

Gold Sponsors

Skyline Steel Corporation
Piling Inc.
Hawaiian Dredging

Bronze Sponsor

Saginaw Pipe

A Special Thanks To Our Winter Roundtable Corporate Sponsors

The 7th Annual Winter Roundtable would not have been possible without the generous support of our Corporate Sponsors.

This makes it possible for our attendees to enjoy most of the special events of the Roundtable – from coffee breaks to receptions.

PDCA MEMBERSHIP APPLICATION

Step 1: Select Membership Type

I wish to apply for the following membership status (check one)

❑ **Contractor ($650 / year)**
A Contractor Member is defined as a specialty subcontractor or general contractor who commonly installs driven piles for foundations and earth retention systems. Includes one primary membership. Secondary memberships are $75 each.

❑ **Associate ($650 / year)**
Associate Members of the Association shall consist of firms or corporations engaged in the manufacture and/or supply of equipment, materials, testing or other services to the pile driving industry. Secondary memberships are $75 each.

❑ **Technical Affiliate ($95 / year)**
Technical Affiliate Members of the Association shall consist of individuals who are involved with the design and installation of driven piles or in teaching the art and science of pile design and installation. They may be employed engineers, architects, government agencies, or universities. Employees of contractors are not eligible to become Technical Affiliate Members. Note: Technical Affiliate Membership category is for individuals only. For a company listing in the directory and on the Web site, you must join as an Associate Member.

❑ **Retired Industry Member ($50 / year)**
A retired member shall be defined as any individual who has reached retirement age as defined by U.S. law, who has left active employment and who wishes to remain a member.
I am retiring as a: ❑ Contractor ❑ Associate ❑ Technical Affiliate

Step 2: Demographic Information

Title: ❑ Mr. ❑ Mrs. ❑ Ms. ❑ Dr. ❑ Prof. ❑ Other

Business Title ______________________ Business Phone ______________________

Name ______________________ Business Fax ______________________

Company Address ______________________ Primary Email ______________________

Business Address ______________________ Home Page ______________________

City/State/Zip ______________________

Step 3. Company Description (complete only the category for which you are applying)

A. Contractor Only Company Description (check all that apply):

❑ Bridge Building
❑ Bulkheads
❑ Deep Dynamic Compaction
❑ Deep Excavation
❑ Docks & Wharves
❑ Earth Retention
❑ General
❑ Highway & Heavy Civil
❑ Marine
❑ Pile Driving
❑ Other______________________
❑ Other______________________

B. Associate Company Only Company Description (check all that apply):

Accessories

❑ Cutter Heads & Drill Bits
❑ Dock & Marine Supplies
❑ Hammer Cushions
❑ Hoses & Fittings
❑ Lubricants & Greases
❑ Pile Cushions
❑ Pile Points & Splicers
❑ Rigging Supplies
❑ Safety Equipment
❑ Other______________________

Applications By Systems

- ❑ Aluminum Sheet Piles
- ❑ Coatings & Chemicals
- ❑ Concrete Piles
- ❑ Composite Piles
- ❑ H-Piles
- ❑ Steel Pipe Piles
- ❑ Steel Sheet Piles
- ❑ Structural Steel
- ❑ Synthetic Material Piles
- ❑ Other______________________
- ❑ Timber Piles:
- ❑ Treated Lumber & Timbers
- ❑ Vinyl Sheet Piles
- ❑ Other Structural Materials

Equipment

- ❑ Air Compressors
- ❑ Cranes
- ❑ Drill Equipment
- ❑ Drive Caps & Inserts
- ❑ Hammers
- ❑ Hydraulic Power Packs
- ❑ Leads & Spotters
- ❑ Pumps
- ❑ Specialized Rigs & Equipment
- ❑ Other

Services

- ❑ Consulting
- ❑ Design
- ❑ Freight Brokerage
- ❑ Geotechnical
- ❑ Marine Drayage
- ❑ Surveying
- ❑ Testing
- ❑ Trucking
- ❑ Vibration Monitoring
- ❑ Other ___________________

General

❑ Rental ❑ Sales ❑ Other ________________ ❑ Other _____________________

C. Technical Affiliate Only (check all that apply)

- ❑ Analysis
- ❑ Geotechnical
- ❑ Surveying
- ❑ Civil & Design
- ❑ Materials Testing
- ❑ Vibrating
- ❑ Consulting
- ❑ Pile Driving Monitoring
- ❑ Other
- ❑ Educational/Association

Step 4. Geographic Areas Where Contracting, Products and Services Available

(All applicants check all that apply)

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

Step 5. Sponsorship: Who told you about PDCA?

Member Name___________________________________

Step 6. Method of Payment

Attached is my payment of $___________ for annual dues.

❑ I understand that dues are due annually on December 31, and that if I joined PDCA after March 31 I may be entitled to aprorated dues amount for the subsequent year only.

I am making payment in full by

❑ Check # ____

❑ Credit Card: ❑ MasterCard ❑ Visa ❑ American Express

Card Number: ____ Expiration Date:________________________

Name as it appears on card: ______________________________ Signature:____________________________________

Please send this completed application to: PDCA

P.O. Box 19527, Boulder, CO 80308-2527 | Phone: 303-517-0421 | Fax: 303-443-3871 | www.piledrivers.org

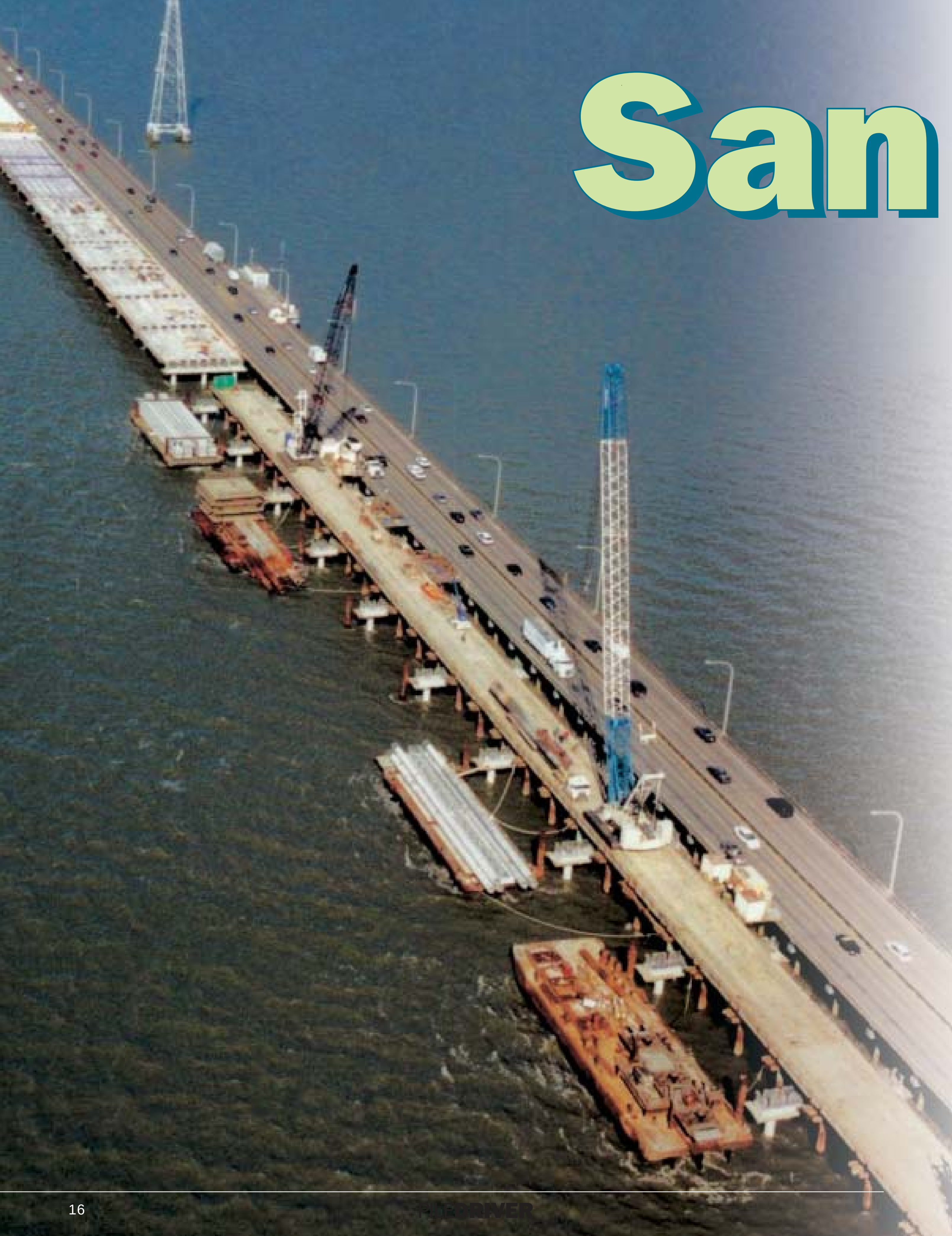
PDCA
PILE DRIVING CONTRACTORS ASSOCIATION

2002 Driven Pile Project of the Year Award Goes to Balfour Beatty

In order to acknowledge noteworthy contributions to the industry, the PDCA annually recognizes an outstanding project that utilized driven piles to solve foundation problems. The winner is selected based on qualities such as innovation, timeliness, unusual aspects of piledriving, unique solutions to foundation problems, value engineering and value to the public or industry.

The PDCA is proud to announce that the winner of the 2002 Project of the Year award is Balfour Beatty's San Mateo-Hayward Bridge project in California. The award was presented to Mark Johnnie of Balfour Beatty by the PDCA's Public Relations Committee Chairman Steve Whitty at the Winter Roundtable Conference in Atlanta. The PDCA wishes to thank Vulcan Foundation Equipment for donating the award trophy.

San



Mateo's

Impressive Bridge Project **Finishes on Schedule**

By Lisa Kopochinski, Piledriver Editor

Now that the widening of the San Mateo-Hayward Bridge in San Francisco's Bay area is complete, Mark Johnnie, project manager with Balfour Beatty, general manager on the project, can breathe both a sigh of relief and recall what he enjoyed most about the experience.

"Like all projects I work on, I enjoy the people the most," he says. "It is very rewarding to assemble a group of people, pose them with a challenge, work with them through the struggles and watch them perform. I know this doesn't always happen on projects, but it did at San Mateo and I am very proud of the people who worked on this project."

"A once terrible commute is now a breeze!"
Bill Heston, Balfour Beatty

The project – the winner of the 2003 PDCA Project of the Year Award – involved constructing a new 4.7-mile long trestle portion of the 7.5-mile San Mateo Bridge so that three lanes now run in each direction over the length of the bridge.

Valued at nearly $133 million, it was finished on schedule by Balfour Beatty and the numerous subcontractors that helped, such as San Francisco-based Ben C. Gerwick, which performed pile driving analyses as an engineering consultant for the project.

"We were consulting engineers to Balfour Beatty," says Pat Durnal, Ben C. Gerwick's senior engineer. "We used the 97 version of GRL WEAP (wave equation analysis program) to help Balfour Beatty decide which hammer to purchase prior to the test pile installation. Then, before the test pile installation, we performed a preliminary drivability analysis and estimated [that] the tension stresses could be too high because the design effective prestress for the 42-in. prestressed concrete piles might be too low. This was because the piles had number nine rebar in between the prestressing strands, which had not been considered in the effective concrete prestress calculations."

Durnal added that when the concrete area was transformed to account for the rebar, the area was large and the effective prestress in the concrete was too low. "It is primarily the effective prestress that resists tension stresses, so Caltrans [California Department of Transportation] agreed to add more prestressing strands to their design," he explains.

Completed on time

Balfour Beatty finished the 700 working-day project in February, driving more than 800 42-in. diameter prestressed concrete cylinder piles, including test piles into "classic bay mud, which is a mix of sand, silty sand and clay, among other things," says Johnnie.

The new bridge also required nearly 300 precast concrete caps, more than 2,100 precast, prestressed concrete girders; 19,000 precast, prestressed concrete flat tabs; 12 million pounds of structural steel reinforcement; and 50,000 cu. yds. of structural concrete.

"Achieving this goal required intense focus by all -- crafts persons, subcontractors, suppliers, and the project management team itself."

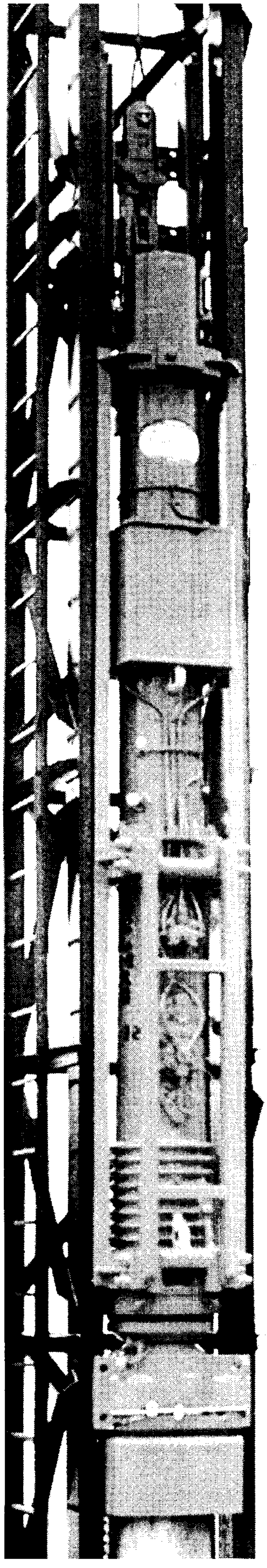
MARK JOHNNIE, PROJECT MANAGER WITH BALFOUR BEATTY

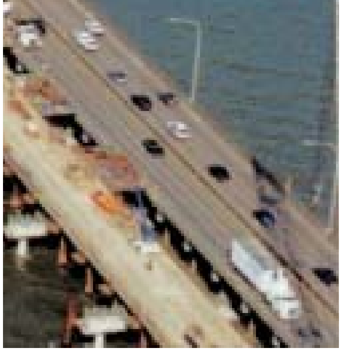
"Our goal of achieving 270 ft. of bridge construction every week was the most difficult challenge on the project," notes Johnnie. "Achieving this goal required intense focus by all – crafts persons, subcontractors, suppliers, and the project management team itself. With a project that is so repetitive, the initial thinking was that we would get the project set up, experience a learning curve and then the project would be on autopilot until the end. The reality was that "autopilot" from a project management perspective and, as we dreamed about at the beginning of the project, never actually happened. It did in the field, but the daily effort required to coordinate all of activities that ultimately resulted in the production of 270 ft. of bridge per week was tremendously challenging."

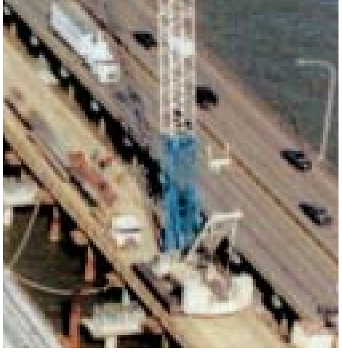
Bill Heston, Balfour Beatty's project engineer adds that another major challenge lay in setting the job up to enable aggressive production goals to be reached or exceeded.

"Because the shallow San Francisco Bay water in the area of the San Mateo Bridge does not allow for construction using normal marine equipment, this project had to be constructed from a moveable temporary erection platform (work trestle)," Heston explains. "So, the biggest challenge was to design, and place into use, a work platform that could support the heavy loads applied by two 250T cranes (Manitowoc M250 and Sumitoma SC2500) while hoisting the large precast concrete elements, yet be easily dismantled and moved ahead as the project exceeded."

Ben C. Gerwick's Durnal recounts the largest challenge of the project as the spalling test piles and initial concerns that the







spalling might plague the entire progress of the job.

Delmag D100-13 Used

To drive both the 36-in. work trestle pipe pile and 42-in. concrete cylinder piles, Balfour Beatty's Heston says a Delmag D100-13 hammer and heavy-duty offshore leads were used.

"A special forged steel "follower" was needed for driving concrete pile due to rebar protrusion of about five ft. We used an Ice 66-80 vibratory hammer to extract the work trestle pipe pile," he adds.

These hammers, and assistance with major maintenance, were provided by PDCA Member Company Pilemac Inc. of Livermore, while Specialty Piling Systems of Slidell, LA, also a PDCA member, supplied the pile cushions used to drive the precast prestressed cylinder pile.

"Thankfully, all the project participants ultimately gave in a little and provided a better drivable project," says Durnal. "The conscientiousness of Balfour Beatty managers, project engineers and superintendents made things happen the right way."

For Heston, the sense of accomplishment when a job is successfully completed and placed in its intended usage is what he enjoyed most about this project.

"This particular project, however, is unusual in its physical strength and repetition," he says. "Thus, it was subject to potentially devastating results if planned productions were not achieved. It's particularly satisfying to have avoided this scenario and actually bettered planned productions while providing Caltrans with a quality product that the driving public is now enjoying immensely. A once terrible commute is now a breeze!"

Durnal concurs: "Whether asked to visit the site to help solve a problem or just flying over the bridge at night to catch a glimpse of the large Manitowoc crane and Delmag D100-13 hammer sitting out there on a temporary trestle, I was always proud to be associated with the great works set in motion by Balfour Beatty and Caltrans." ▼

PDCA New Member List

We would like to welcome the following companies as new members. Please visit the PDCA Web site at www.piledrivers.org and click on Member Search for complete contact information on all PDCA members.

NEW CONTRACTOR MEMBERS

All American Underpinning and Shoring
Roselle, Illinois
Contact: Michelle Lusader
Services Provided: Bridge Building, Bulkheads, Docks & Wharves, Earth Retention, Highway and Heavy Civil, Pile Driving.

F&W Construction Company, Inc.
Ozark, Alabama
Contact: Nigel Wells
Services Provided: Bridge Building, Bulkheads, Earth Retention, Marine, Pile Driving

Lorig Construction
Des Plaines, Illinois
Contact: David Lorig
Services Provided: Bridge Building, Earth Retention, Highway and Heavy Civil, Pile Driving.

NEW ASSOCIATE MEMBERS

GZA GeoEnvironmental, Inc.
Norwood, Massachusetts
Contact: Bradford W. Roberts
Services Provided: Geotechnical Design and Consulting, Dynamic Pile Testing, Vibration Monitoring, Instrumentation.

PDCA
PILE DRIVING CONTRACTORS ASSOCIATION

The Pile Driving Contractors Association (PDCA)

is soliciting nominees for the

"Driven Pile Project of the Year" (2003)

As a means of recognizing noteworthy contributions to the industry, PDCA will recognize an outstanding project that utilized driven piles to solve foundation problems.

Qualification for nomination requires projects only to involve driven piles, that the piledriving be completed during 2002 or 2003, and that at least one participant was a PDCA member during the year as a contractor, technical affiliate or as associate member. Projects will be judged on qualities such as, but not limited to, uniqueness, timeliness, unusual aspects of piledriving or unusual solutions to foundation problems, value engineering or value to the public or industry.

Entry forms and rules are available at:
PDCA Web site: www.piledrivers.org
PDCA office: 888-440-7453 (PILE)

The winning project will be presented an award at the PDCA 2004 "Winter Roundtable."

Nominations will close December 1, 2003.

World War II Memorial Proceeds On Time

Towards 2004 Dedication Ceremony

PHOTO COURTESY: R. LATOFF, WWII

By Lisa Kopochinski, Piledriver Editor

When completed next spring, the World War II Memorial will be the first national monument dedicated to those who served in that war. It is also the only 20th Century historical event commemorated on the central axis of Washington, DC's National Mall.

Located at the Rainbow Pool site, general contractors J.A. Jones, Tompkins Builders and Grunley Walsh are currently about 70 percent complete on the project. The total estimated project cost, including design and construction, is about $170 million. [Funding was provided almost exclusively from private contributions].

Explains Stephanie Szebalskie of J.A. Jones/Tompkins, "Our scope of work includes building the structure, consisting of 56 17-ft.-tall granite pillars representing each state, territory and the District of Columbia during the [Second World War]; arched pavilions on the north and south ends of the plaza to be dedicated to the war's Atlantic and Pacific theaters; and 24 bronze low reliefs to depict various military and civilian aspects of the war."

International architecture firm Leo A. Daly headed up the design team, which included principal design architect Friedrich St. Florian. Bronze and granite – the latter for its aesthetic appeal, strength and durability – was chosen for the Memorial. The plaza and Rainbow Pool are the principal design features, unifying all the different elements. Two flagpoles flying the American flag will frame the ceremonial entrance at 17th Street. The bases of granite and bronze will be adorned with the military service seals. Ceremonial steps and ramps lead from 17th street into the plaza. A series of 24 bronze panels along the ceremonial entrance depict the country's war years, at home and overseas.

Midlantic Piling Inc. of York, PA. performed pile driving activities at the site, where the Memorial sits on a perimeter slurry wall and nearly 600 steel H-Piles.

Skyline Steel of Fairfax, Va. was the material supplier to Midlantic. Skyline Steel Sales Representative Dan Brown says the company provided approximately 850 tons of HP 14 x 89 bearing piles for the foundation and about 200 tons of steel sheet piling for support of excavation for the Memorial.

Midlantic chose a new Link-Belt LS-218H Series II, conventional crawler crane, with a 130-ft. boom to accomplish the important bearing pile driving phase of the work. The

> **"The reclaimed area is very soft. You can see the ground pumping as we [worked] on it. It [was] not a very strong soil above the bedrock, but the bedrock was tough."**
>
> William J. Lytle, President, Midlantic Piling Inc.

110-ton capacity crane supported a 15,900-lb. ICE 60S single-acting diesel pile hammer, and 96-ft. long swinging leads. A Link-Belt 75 ton crane with a 120-ft. boom, rented from United Crane & Rigging of Baltimore, handled the two vibratory hammers being used to drive and extract the sheet pile.

Midlantic Piling Inc. President William J. Lytle said the new Link-Belt crane was equipped especially for the heavy-duty pile driving application and that everything about the machine was geared to this goal. This included an optional third drum and a boom selected for its ability to withstand the daily rigors of this function. The footprint of the LS-218H II provided the stability necessary for the crane to work easily on many types of ground projects.

Lytle added that this is very important because the construction site was initially a swamp area that was later filled in with various materials. "The reclaimed area is very soft," he explains. "You can see the ground pumping as we [worked] on it. It [was] not a very strong soil above the bedrock, but the bedrock was tough."

Jim McCloskey, Tompkins Builders project manager, added that the contract called for the driving of between 500 and 600 14BP x 89 bearing piles, up to 55 ft. in length.

PHOTO COURTESY: R. LATOFF, WWII

"The majority of the bearing pile, in the foundation area, is about 35 ft. long," he explains. "The bearing piling is being driven to refusal in bedrock. Refusal criteria are defined as no less than 10 blows to the inch."

The contract also included the installation and removal of 1,600 ft. of protective sheet pile. Lengths varied from 25 ft. to 35 ft. Some of these were driven in owner-designed vault areas, while others were driven in contractor-designed tunnel areas.

As for challenges to date, Szebalskie says harsh weather this winter caused the team to work multiple shifts to stay on schedule. "Also, 100,000 cu. ft. of dimensions and stone (granite) needed to be fabricated within 18 months. Five different fabricators were employed to complete the work," she says.

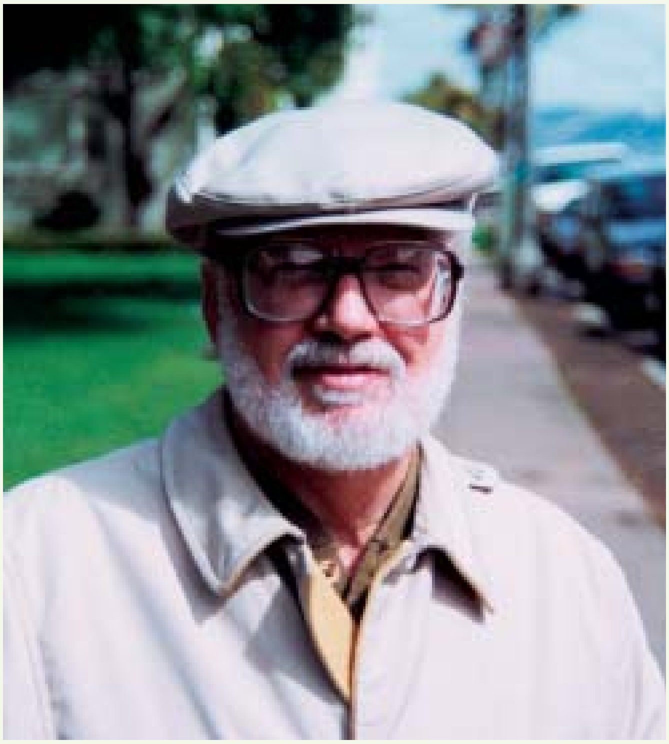
Barry Owenby, project executive at the American Battle Monuments Commission (ABMC), an independent agency of the executive branch of the federal government overseeing the project, concurred: "Probably the greatest challenge has been the site itself," he says. "We have a 7.4-acre site on the National Mall between Constitution and Independence avenues, so site egress, as well as appearance has been a major concern. We do not want to detract from the visitor's experience and are striving to present the site in the best light possible, while realizing we have major construction in progress."

A dedication ceremony is planned for the 2004 Memorial Day weekend. A commemorative area at the western side of the Memorial recognizes the sacrifice of America's WWII generation and the contribution of our allies. A field of 4,000 sculpted gold stars on the Freedom Wall honors the more than 400,000 Americans who gave their lives. [During WWII, the gold star became the symbol of family sacrifice].

Skyline Steel's Brown puts it succinctly: "The Memorial stands as a tribute to the sacrifices our country has made and continues to allow us to enjoy the freedoms that we have." ▾

PDCA Founding Member
Charles Whiteaker Recalls Fond Memories

By Jennifer Bernal



Fifty years ago, Charles Whiteaker set world track records at the University of Michigan while he studied to be a teacher.

Today, he is known for being a founding member of the Pile Driving Contractors Association as well as for his career as vice president of marketing at Larkspur, CA- based Skyline Steel Corp.

Though currently retired, Whiteaker, 73, says he made the switch from teaching to construction purely by chance. He didn't think he could raise a family on a teacher's salary so, after two years in the army, he accepted a job in the steel industry where he sold H-piles, sheet piles and pipe piles to pile drivers.

After working for more than 30 years in the steel industry, Whiteaker realized there were major threats to his company and pile drivers across America. This prompted him to found PDCA in 1996.

"The market was being invaded by alternative methods to pile driving," he explains. "We needed to preserve and expand the market for driven pile. I thought that PDCA could help bring people together to ward off and fight against competitors in the industry."

He was not alone in his thoughts.

"George Goble, of George Goble Consulting and Engineering in Boulder, CO, prodded me to start the organization. He felt there was a need for it and has been a major contributor to its success," Whiteaker ascertains.

The two worked together to build the organization. The first step was finding members. The primary source for the first members was a Skyline Steel customer list. Once they were organized and had members, they set modest dues for fun programs and activities to support the driven pile industry.

It is Whiteaker's strong corporate philosophy that helped make PDCA successful. He believes in honesty, dependability and long-term personal relationships.

"A favorite saying of mine is that the customer is not always right, but he is always the customer," Whiteaker said. He also believes that employee relations is an important factor in whether a company is successful.

"I was very lucky at Skyline Steel. The company's philosophy very closely matched my own and there was an excellent management team. It also helped that we had the best sales force in the industry and were very well financed."

Another key to his success was his determination to keep up with the times. Whiteaker read several technical and trade magazines and attended conferences given by the American Institution of Steel Construction. He also served as a board member for Structural Steel Education Council and West Coast Metal Importers Association and seized any opportunity he could to learn more about the industry and the products he was selling.

This showed through in his sales success. Whiteaker sold 14,000 tons of H-piling and 2,000 tons of HZ Wall that were used to build the foundations and two cofferdams on the Columbia River Bridge project in Portland, Oregon.

One of the more memorable sales experiences of Whiteaker's career was when he sold sheet piling that was delivered to an air force base for runway repair.

"The sheet piling was delivered by a cargo plane," Whiteaker recalls. "This does not normally happen because the materials are so heavy."

When asked about his fondest memory of PDCA, it is hard for him to name just one.

"The companionship and camaraderie with members was great. I enjoyed [it all] very much."

Whiteaker is very pleased with how the association is doing and sees PDCA as having an opportunity for continued growth.

"We have very knowledgeable members, but the main thing we have to do is keep expanding membership and trying to groom younger people to become involved and carry on," he says. "A lot of people do not join, but benefit from the organization. Our challenge is to get these people involved."

Whiteaker is also a bit nostalgic about his time working with PDCA.

"I would rather be working with friends than be retired. But, unfortunately, age comes to all of us." ▼

Safety Factors for Pile Testing

By Garland Likins

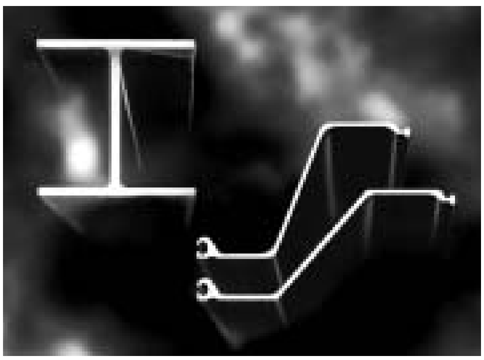
When designing a foundation system, engineers have many choices, including the ultimate load per pile and pile size (type, length and diameter). The ultimate pile capacity must exceed the applied loads by a sufficient margin or the foundation will have unacceptable settlements. The required pile capacity also depends on the test method for verification of the pile capacity and the frequency of testing. This paper compares safety factors contained in the PDCA's "Recommended Design Specifications for Driven Bearing Piles" with factors from other published codes.

Safety factors are assigned to lower the risk of foundation failure. They compensate for uncertainties from unknown loads or loading conditions, from site variations and from inaccuracies in load determination methods. Additional geotechnical considerations like consolidation in compressible layers and negative friction are beyond the scope of this discussion. Statistical methods can be employed to assess risk. These statistical methods form the basis for the safety factors proposed by modern codes such as the PDCA code.

Safety factors are either (a) "global" for allowable stress designs (ASD), or (b) "partial" for load and resistance factor (LRFD) designs. In allowable stress design, the ultimate pile capacity is divided by a global safety factor to find the allowable or working load on the pile. Thus all uncertainty is lumped into this single factor.

LRFD design recognizes that different loading conditions have different uncertainty and therefore assigns different applied "load factors." For example, the structure's dead weight is known while the applied live loadings due to wind, earthquake or temporary loads can be highly variable. Thus, load factors for dead weights are lower than for the less certain

NUCOR-YAMATO STEEL'S HP8, HP10, HP12 & HP14 AND PZ SHEET PILING



PILING PRODUCT FEATURES

CAST AND HOT ROLLED IN THE U.S.A.

H-PILING AVAILABLE IN FULL RANGE OF SECTION SIZES

AVAILABLE IN ASTM A572 GRADE 50

NATIONWIDE PILING DEALER NETWORK

SHEET PILES USE PREFERRED BALL & SOCKET INTERLOCK

H-PILE SECTION SIZES

HP14x73	HP14x89	HP14x102	HP14x117
HP12x53	HP12x63	HP12x74	HP12x84
HP8x36		HP10x42	HP10x57

PZ22 AND PZ27 SHEET PILING TECHNICAL DATA

Section Designation	AREA		WIDTH		HEIGHT		WEIGHT (MASS) PER SINGLE		WEIGHT (MASS) PER WALL		MOMENT OF INERTIA		SECTION MODULUS Per Single		SECTION MODULUS Per Wall		SURFACE AREA Total Area		SURFACE AREA Nominal Area*	
	in^2	cm^2	in	mm	in	mm	lb/ft	kg/m^2	lb/ft^2	kg/m^2	in^4	cm^4	in^3	cm^3	in^3/ft	cm^3/m	ft^2/ft	m^2/m	ft^2/n	m^2/m
PZ22	11.86	76.5	22	559	9	229	40.3	60.0	22.0	107.4	154.7	6 440	33.1	542	18.1	973	4.94	1.51	4.48	1.37
PZ27	11.91	76.8	18	457	12	305	40.5	60.3	27.0	131.8	276.3	11 500	45.3	742	30.2	1620	4.94	1.51	4.48	1.37

*Note: Nominal coating area excludes socket interior and ball of interlock.

NUCOR-YAMATO STEEL PILING DEALERS

Ⓗ **Fargo Structural**
Fargo, ND
(701) 282-2345

Ⓗ Ⓢ **Mid-America Foundation Supply, Inc.**
Fort Wayne, IN
(260) 424-0405

Ⓗ Ⓢ **National Pipe and Piling, Inc.**
Federal Way, WA
(253) 941-7000

Ⓗ **D.P. Nicoli, Inc.**
Tualatin, OR
(503) 692-6080

Ⓗ **Husker Steel**
Columbus, NE
(402) 564-3271

Ⓗ **J. D. Fields and Company, Inc.**
Plainfield, IL
(815) 577-7700
Bethlehem, PA
(610) 317-6304
Houston, TX
(281) 558-7199

Ⓗ Ⓢ **Skyline Steel Corporation**
Cropwell, AL
(205) 338-7774
Citrus Heights, CA
(916) 863-6000
Norcross, GA
(770) 242-9007
Tinley Park, IL
(708) 444-0999
Metairie, LA
(504) 835-4222
East Sandwich, MA
(508) 833-4600
Earth City, MO
(314) 739-1303
Middletown, NJ
(732) 671-5900
West Chester, OH
(513) 777-7039
Pittsburgh, PA
(412) 561-3995
Pearland, TX
(281) 992-4000
Fairfax Station, VA
(703) 978-2500
Gig Harbor, WA
(253) 858-9405

Ⓗ Steel H-Piling Dealer Ⓢ Steel Sheet Piling Dealer

NUCOR-YAMATO STEEL COMPANY
POST OFFICE BOX 1228 • BLYTHEVILLE, ARKANSAS 72316
870/762-5500 • 800/289-6977 • FAX 870/763-9107

live loads. LRFD methods assign different strength factors (often called “resistance factors” with values less than unity) which relate to the verification procedure reliability. The general expression for LRFD design is

$$\Sigma\, \gamma_i\, Q_i \leq \Phi_k\, R_k$$

Where γ_i is the load factor for the load Q_i of the ith load type (e.g. γ_1 might be 1.4 for the dead load Q_1, and γ_2 might be 1.7 for the live load Q_2), and Φ_k is the resistance factor for the resistance R_k for the kth limit state (e.g. Φ might be 0.80 for a static load test R on 1% of the piles). In concept, for a given set of load and resistance factors, an equivalent global safety factor can be calculated from the load factor divided by the resistance factor (e.g. in the above examples, the equivalent global safety factor is 1.94 for a 50% dead load situation). Further mention of LRFD in this article will use computed equivalent global factors.

The risk of foundation failures makes capacity evaluation necessary. Logically, less testing increases the risk of a failed foundation, while more testing reduces risk. Similarly, more accurate test methods reduce risk, while less accurate methods increase risk. The goal is an acceptably low probability of failure. Piles can potentially fail either due to structural failure or geotechnical failure (e.g. soil strength). Generally, driven piles rarely fail structurally (drilled or augered piles have a higher probability of structural failure and thus usually have higher associated safety factors, or lower γ factors on the structural strength conditions).

Static Load Testing has traditionally been the standard for evaluating soil strength and ultimate pile capacity. Prior to about 1970, piles were loaded using a slow maintained load procedure over several days to twice the design load, as specified in ASTM D1143. Generally, only one static test was performed per site and these “proof tests” rarely

Global Safety Factors - Allowable Stress Design Values

Australia

Code year design loads	**PDCA** **2001**	AASHTO 1992	IBC 2000 2000 >40T	AS2159-95 1995	ASCE (20-96) for driven pile types 1996 16 to 40 T	 40 to 100T	 >100T	ASCE (non-driven piles) >100T
static analysis notes:	**3.50**	3.50	6.00	2.12 to 3.44	NA	NA	NA	NA
dynamic formula notes:	**3.50**	3.50	NA	2.50 to 3.06 c	2.0 to 2.4 h	NR	NR	NA
wave equation notes:	**2.50**	2.75	NA	2.50 to 3.06	1.8 to 2.2 h	1.9 to 2.3 h	NR	NA
dynamic testing notes:	**1.9 to 2.1** **a**	2.25	2.00 b	1.72 to 2.12 “a, f, g”	1.6 to 2.0 h	1.7 to 2.0 h	2.0 to 2.4 h	2.6 to 3.6 h
static testing notes:	**1.8 to 2.0** **d**	2.00	2.00	1.53 to 1.93 “f, g”	1.5 to 1.8 h	1.6 to 1.9 h	1.8 to 2.2 h	2.3 to 3.2 h
static & dynamic notes:	**1.65 to 1.9** **“a, b, e”**	1.90	 j	 j	 j	 j	 j	 j

Notes

- a dynamic testing requires signal matching
- b requires correlating static test
- c dynamic formula for sands only - not clays
- d <2% static
- e >1% static or >3% dynamic
- f higher SF if <3% dynamic or <1% static
- g “lower SF if >15% dynamic or >3% static, and extensive site investigation with careful construction control”
- h “depends on pile type, site variability, load conditions, etc.”
- j not specifically addressed
- NA - not applicable
- NR - not recommended

failed. The traditional safety factor of 2.0 was thus established because of this loading to only twice design, even though actual safety factors were larger since the pile did not fail. Common failure load evaluations were determined by some pile top movement limit (typically 0.75 to 1.5 inches), or a net movement limit (typically 0.25 to 0.75 inches) after load removal. Due to recent emphasis by the FHWA, the quick procedure static test method detailed in ASTM D1143 is becoming common, the evaluation for failure or ultimate uses the offset yield line method, and the loads are often carried to failure or to at least three times design in a test taking only a few hours. The PDCA code follows this guidance.

When the ultimate failure load can be determined, rather than only a proof load, foundation costs can be potentially reduced. For large projects, special preconstruction test programs are effective. Fewer piles are required when higher loads are proven, or shorter piles can be used. For smaller projects, the first production piles serve as “test piles” and some driving criteria adjustment and cost savings are possible if the piles can be shortened. Production piles are driven to the test pile criteria.

However, it is not practical to statically test every pile because of time and cost constraints. Therefore, static testing is usually limited to a very small sample of piles on any site (typically 1% or less on large projects, or often only one per site, if any, for small projects).

When static testing is performed properly, the measuring accuracy should be within 20% of the true value. The reliability of results is improved if a recently calibrated load cell is specified. However, interpretation of the resulting load-settlement graph can give several different ultimate loads depending on the evaluation method (e.g. Davisson, Chin, Butler-Hoy, double tangent, slope, D/10, etc).

In the extreme case where every pile is tested with a very accurate method (e.g. static load test) with a conservative failure definition, the safety factor can be significantly reduced because the risk is reduced. The offset yield line criteria recommended by the PDCA code is among the most conservative of failure criteria and thus justifies lower safety factors.

The PDCA code awards lower safety factors for testing more piles, because the uncertainty is reduced. For testing only 0.5% of the piles, a safety factor of 2.0 is suggested, while if 5% of the piles are tested, then the safety factor can be reduced to 1.65. Piles are selected so site variability is adequately addressed, and adequate hammer performance is periodically verified. Lower safety factors means the pile load can be increased, resulting in fewer piles, or that the driving criteria can be relaxed, thus reducing production pile installation time and costs. The extra testing costs are more than compensated by reduced foundation costs.

Dynamic Pile Testing is a routine pile capacity evaluation method. Dynamic testing requires measuring pile force and velocity during hammer impact and subjecting this data to a signal matching analysis to determine the soil behavior. Extensive correlations between static and dynamic testing have verified the method's reliability. After correlating the static and dynamic tests, the PDCA code allows substitution of three dynamic tests for one static test in determining the quantity of further testing. Thus, with at least one successful correlation, then the PDCA suggested 5% static testing can be translated into testing 15% of the piles dynamically, for the same suggested safety factor of 1.65. The large number of tests allows site variability and hammer performance consistency to be properly assessed.

In many cases, dynamic pile testing has completely replaced static testing. In this case, no site-specific correlation is established and thus there is a higher risk, since the correlation depends upon past experience of the signal matching analysis accuracy. This extra risk requires an increased safety factor compared with static testing methods. In this case, the safety factor can vary from 2.1 with only 2% of the piles tested dynamically down to 1.9 when at least 10% of the piles are tested dynamically.

To obtain a reliable ultimate capacity from dynamic pile testing, some very basic guidelines must be followed. The hammer input must be sufficiently large to produce a minimum set per blow so the soil is loaded plastically and thus mobilizes the full soil strength. In cases where the set per blow is very small (e.g. large "blow count"), the dynamic pile test will only activate a portion of the full soil strength and thus will under-predict the true ultimate capacity (this is analogous to a "static proof test"), so the result is conservative. Finally, the pile capacity often changes with time after installation (usually increases due to "setup," although in some cases reduction due to "relaxation" are found). To measure time dependent capacity effects, the pile should be tested by restrike after an appropriate waiting time. Restrike tests are recommended standard practice for capacity evaluation by dynamic pile testing.

Dynamic testing provides other benefits. Dynamic pile testing provides valuable additional information on driving stresses which, if too large, can result in pile damage. Pile integrity can be evaluated dynamically for both location and extent of damage, if any. Proper hammer performance is extremely important for driven piles because engineers rely on the blow count (or set per blow) as a driving criteria for pile acceptance, thus implicitly assuming that the hammer is performing properly. By monitoring periodically throughout larger projects, it can be assured that the hammer is performing properly and consistently during the entire project so that the same initial driving criteria can be used for all piles with confidence. Periodic testing can check site variability and investigate the cause of piles that are too short or too long or that have unusual blow count records to determine if the cause is the hammer or the pile or the soil. These guidelines

PILING RIGS

IN STOCK!!

AVAILABLE FOR RENTAL!!

RENTAL PURCHASE OPTIONS AVAILABLE!!

FINANCING AVAILABLE!!

PVE Cranes & Services has introduced a line of Piling and Drilling rigs with self-erecting leaders into the U.S. market. We are currently stocking a number of PVE Model 5021-S rigs in various configurations, which are available for rental as well as sale. The PVE 5021-S has a standard leader length of 82.7 with a 10 ft. extension available. This rig's capabilities include driven pile installation (20 ton combined hammer/pile weight), ACIP/CFA pile installation (to torques up to 100,000 ft./lbs.), and sheet pile installation using a vibratory hammer. Mobilization times are cut to a minimum because the leader is hydraulically self-erecting so that you can start pile installation in a minimal amount of time after arrival at the job site. Hydraulically extendable tracks and counterweight combine optimal stability with ease of transport. With base machine weights from 32 to 82 tons, PVE can build a machine that suits your specific needs. We are now N.Y. City Department of Buildings, Division of Cranes & Derricks approved!

PVE Piling Equipment, Ltd.
PVE Cranes & Services, Ltd.
601 Bryan St.
Jacksonville, Fla. 32202
Tel.: (904) 354-1940
Fax: (904) 354-1942

Northeastern Sales Office
33 Taylor Rd.
Wharton, N.J. 07885
Tel.: (973) 659-1446
Fax: (973) 659-1447

E-mail: info@pveusa.com
Web site: www.pveusa.com

PVE Model 5021-S driving 12" pre-stressed concrete piles with a Pilemer Model DKH-5L Hyd Impact Hammer rated at 43,398 ft./lbs.

VIBRATORY HAMMERS

PVE manufactures standard, high frequency, and high frequency w/ variable moment vibratory hammers. Well known for manufacturing equipment built with an unmatched quality, PVE has recently begun designing hammers specifically for the U.S. market. The PVE Model 2500 Vibratory Hammer was introduced at ConExpo. It is a 2,500 inch/lb. hammer with a suspended weight of 9,350 lbs. And keep your eyes open for the new 48M!

for checking site variability and periodic hammer verifications are mentioned in the PDCA code.

Wave Equation Analysis is a computer simulation of the pile driving process. A numerical model is constructed for the hammer, for the pile, and for the soil. Numerous assumptions are made, such as hammer performance and soil response behavior. Assumed ultimate capacities are entered, a one dimensional wave propagation analysis is made, and the resulting blow counts are predicted. A series of assumed resistances and associated predicted blow counts produce a "bearing graph" to establish a suggested driving criteria. However, because of the increased uncertainty associated with the assumptions, the risk is increased and thus the safety factor in the PDCA code is suggested as 2.5.

Dynamic Formula were developed over 100 years ago to estimate pile capacity by simple energy considerations. Some engineers still use them today to make a preliminary selection of hammer size. However, these methods are very simplistic. Numerous studies have concluded that their prediction accuracy is poor and, to minimize risk, large safety factors are necessary. The standard ENR formula, for example, has a built-in safety factor of 6. Recent studies have shown that the Gates formula is statistically the best for prediction. The Gates formula is the only formula currently recognized by the PDCA, AASHTO, and the FHWA (although FHWA strongly recommends that dynamic formula be replaced by wave equation analysis). Since accuracy is relatively poor and risk increased, the recommended safety factor by PDCA for the Gates formula is 3.5.

Static Analysis estimates pile capacity from soil strength estimates obtained from site soil investigations. Numerous correlations and empirical correction factors for soil strength were developed for SPT, CPT, or other soil sampling tools. However, there generally is considerable scatter of strength prediction results and local experience does not transfer to differing conditions or differing sampling methods. Numerous prediction events have demonstrated that such predictions are generally highly inaccurate. Because of large inherent risk due to poor prediction accuracy, the PDCA code requires a safety factor of 3.5 for piles installed to a static analysis criteria only for an acceptable level of risk.

Comparison of the PDCA Code with Other Codes is summarized in the accompanying table and provides an interesting platform for discussion. The PDCA code origin started with the AASHTO Standard ASD code from 1992.

AASHTO (American Association of State Highway and Transportation Officials) represents the 50 state highway departments plus the FHWA. Subsequently, AASHTO is moving toward LRFD

but the result is still under development. Because of similarities of origin, factors for static analysis and dynamic formula are identical to the PDCA code. AASHTO recognizes that wave equation analysis is more reliable than dynamic formula so the safety factor is set at 2.75. Dynamic testing does not specifically mention signal matching and thus may partially account for the relatively high factor 2.25 for dynamic testing. Static testing alone has the traditional standard factor of 2.0. Testing both statically and dynamically results in a lower safety factor of 1.9. Generally, the AASHTO code does not address the amount of testing to be performed.

IBC 2000, from the International Building Code, is an effort of the three USA regional building codes to form a single national code. The foundation section comes originally from the Southern Building Code which has its base from the 1940s with an update in 1982 to cover a few "new technology" items missing from the original code (e.g. prestressed piles, et al), but nothing new relating to safety factors. The IBC did provides for dynamic pile testing (as per ASTM D4945) as a new inclusion of this new code. This SBC code is obviously the oldest and generally reflects older practice requirements. For piles with design loads under 40 tons, capacity is determined by "an approved driving formula" or by static analysis, with no load testing required. The static analysis uses either a soils investigation or a safety factor of 6 referenced to a chart of conservative soil strengths. For loads of 40 tons or higher, wave equation analysis is specified to estimate the driving criteria, and the load is to be verified by either static or dynamic testing (dynamic testing in ASTM D4945 indirectly implies at least one correlating static test).

In contrast to IBC 2000, the Australian Code AS2159-1995 is perhaps one of the most progressive in the world. AS2159 is an LRFD code and the global factors shown here for comparison are computed from an equal weighting of live and dead loads (having 1.5 and 1.25 load factors respectively). The range of safety factors in the code is given with some guidance by the code. The dynamic formula factors are to be applied to sandy soils only; dynamic formula are prohibited for clay soils. Factors for static analysis are based on the soil exploration method (e.g. SPT or CPT; CPT methods are given higher confidence and thus lower safety factors). The dynamic testing factors require signal matching. Lower safety factors for dynamic testing require at least 15% of the piles to be dynamically tested (and also comprehensive site investigations and careful construction control), while higher factors result when less than 3% of the piles are dynamically tested. The lowest static testing safety factors come from statically testing more than 3% of the piles, while higher factors apply when less than 1% of the piles are statically tested.

The ASCE 20-96 is the Standard Guidelines for the

Design and Installation of Pile Foundations. This code is quite different from others in that the safety factor is defined by three parts (capacity determination method, design axial load levels, and structural pile type). The capacity determination method is the only common criteria with other codes. The latter two criteria have come under some recent criticism ("Proposed Overhaul of Deep Foundation Provisions of the International Building Code" by Len Cobb, presented at the ASCE Geo-Institute Deep Foundations 2002 Conference, Feb 2002). Because of more structural uncertainty, this code requires significantly higher safety factors for non-driven piles. Determination of capacity solely on static analysis is not permitted. Except for lightly loaded piles, dynamic formula are not recommended and no factors are even suggested (factors for lightly loaded piles are unrealistically small for the associated risk). The factors for dynamic and static testing are generally similar to PDCA values for lower pile loads, but the factors are higher than the PDCA values for piles with design loads of 40 tons or more. (This code is currently in a revision process and safety factors are likely to be reduced for the higher load cases).

As a common practice, static analysis methods are generally only used to estimate pile lengths in the design process. Rarely are pile installations governed by this method, so whether a code has a factor or not for static analysis is almost a non-issue. Dynamic formula are also decreasing in usage. They remain mainly a tool for preliminary hammer selection. In most cases, actual use of dynamic formula to govern pile installation are perhaps limited to light design loads. From a practical view, a wave equation analysis is almost as fast and simple as a dynamic formula. Generally, some other more precise method (wave equation, dynamic testing, or static testing) is also specified on most projects, particularly projects with design loads above 40 tons, so the lower safety factor and improved reliability of the more accurate methods would then govern the project anyway.

In summary, keeping the risk of foundation failure below an acceptable level is the goal for any foundation. To accomplish this, safety factors are applied to the ultimate pile capacity to calculate an acceptable design or working load for the piles. The risk of failure can be reduced by testing more piles, or using evaluation methods that are more accurate. A reduced risk of failure justifies lower safety factors. The safety factors recommended by several newer codes generally give a range of safety factors depending on the type and amount of testing performed on site, and result in factors less than the traditional factor of 2.0. These more modern testing methods, combined with a higher frequency of testing and the resulting lower safety factors, can reduce the total foundation costs. ▼

CALL FOR PAPERS

Current Practices and Future Trends in Deep Foundations

A Geotechnical Special Publication Honoring George G. Goble

Jerry A. DiMaggio and
Mohamad H. Hussein – Editors

ASCE-GeoInstitute is sponsoring this GSP in honor of Professor Goble, a distinguished educator, researcher, practitioner, entrepreneur, and visionary who has made significant contributions towards the advancement of the state of the art and practice of deep foundations worldwide. Papers are solicited on the general topic of deep foundations current practices and future trends; preference will be given to papers that cover topics closely related to Dr. Goble's work. ▼

Deadline: **July 11, 2003 for 300-word abstract.**

Contact: **Jerry A. DiMaggio**
Principal Geotechnical Engineer

Federal Highway Administration – FHWA (HIBT-20)
400 7th Street, SW, Room 3203
Washington D.C. 20590

e-mail: jerry.dimaggio@fhwa.dot.gov

Telephone: (202) 366-1569
Fax: (202) 366-3077

Calendar of Events

June 9-13, 2003

Annual Professor's Piling Institute

Utah State University, Logan, Utah

September 18-19, 2003

4th Annual Design and Installation of Cost Efficient Piles (DICEP) Conference

Sheraton Chicago Northwest Hotel

February 21-22, 2004

8th Annual Winter Roundtable Conference

Wyndham Orlando Resort

PILE DRIVING CONTRACTORS ASSOCIATION

Advertiser Index

Four APE Model 400's driving 40 foot diameter concrete caissons weighing 1.3 millions pounds
AMERICAN PILEDRIVING EQUIPMENT, INC.
APE
Call 800.248.8498 for the most aggressive equipment quotes available
APE Model 120VM
AMERICAN PILEDRIVING EXPERIENCE
APE Vibratory Driver/Extractor
APE Hydraulic Impact Hammers
APE Diesel Hammers
APE Pin Together Leads
J&M Vibratory Driver/Extractors
J&M Auger Drives
J&M Spotters
J&M Hydraulic Impact Hammers
APE Model 7.5 Hydraulic Impact