Information for the 11th Annual PDCA International Conference and Exposition

page 15

Aarsleff Supplies Quiet Support

page 43

A Driven Pile Is A Tested Pile: Site Characterization

page 48

PILEDRIVER

The Official Publication of The Pile Driving Contractors Association | Q1 2007 Vol. 4, No. 1

Reconstructing The Roman Circus at Arles

PRSTD STD
US POSTAGE PAID
FARGO ND
PERMIT #1080


Berminghammer
the clean hammer.
Easy-start
Free-standing
Hydraulic Trip
Low Emissions
Ground Fueling
Remote Throttle
Sheet Pile Adapter
Impact Energy Monitor
Berminghammer
FOUNDATION EQUIPMENT
BERMINGHAM
FOUNDATION SOLUTIONS
SINCE 1897
www.berminghammer.com

PILEDRIVER
The Official Publication of The Pile Driving Contractors Association | Q1 2007 vol. 4, no. 1

PILE DRIVING CONTRACTORS ASSOCIATION
P.O. Box 66208
Orange Park, FL 32065
Tel: (904) 215-4771
Toll Free: (888) 311-PDCA (7322)
F: (904) 264-9531
www.piledrivers.org
Email: execdir@piledrivers.org

Published by:
Lester Publications, LLC
2131 NW 40th Terrace - Suite A
Gainesville, FL 32605
Main Line (877) 387-2700

President
Jeff Lester | (866) 953-2189

Sales Director
Sean Davis | (888) 953-2190

Graphic Designer
Mark Simpson | (204) 953-2188

Advertising Representatives
Louise Peterson, Jennifer Shurvell,
Joelle Portis

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

For reprint information, contact
Lester Publications,LLC at (877) 387-2700
For a media kit, visit www.piledrivers.org.

Piledriver is published quarterly.
Please contact us by mail at
P.O. Box 66208, Orange Park, FL 32065
Phone: 904-215-4771 | Fax: 904-264-9531
or by Email at membership@piledrivers.org.

Printed in Canada
Please recycle where facilities exist.

Contents

On the Cover:
Pile Driving Equipment from the 18th Century

Tropical Hardwood

Piling, Decking, Timbers, Fenders and Drag Line Mats

Servicing the Marine Construction & Boardwalk Industry Since 1971

We are the Industry Leader with a proven track record of delivering on time, to specifications, and on budget.

CECCO TRADING INC.
IRON WOODS™

Greenheart
Purpleheart
Ipe / Bethabara
EKKI / Azobe
Cumaru
and more

GREENHEART PILES

Many sizes available from stock
Call for details

CECCO TRADING, INC.

Naturally Durable Hardwoods and Fabrication

For More Information:
414-445-8989 • Fax: 414-445-9155
www.ironwoods.com • info@ironwoods.com

WHEN YOU'RE DRIVING FOR PEAK PERFORMANCE!

- Pipe Pile Points
- Pipe Splices
- Tuftip H Pile Points
- H Pile Splices
- Timber Pile Points
- Timber Uplift Anchors
- Sheet Pile Shoes
- Pile Safety Covers
- Pipe Chill Rings

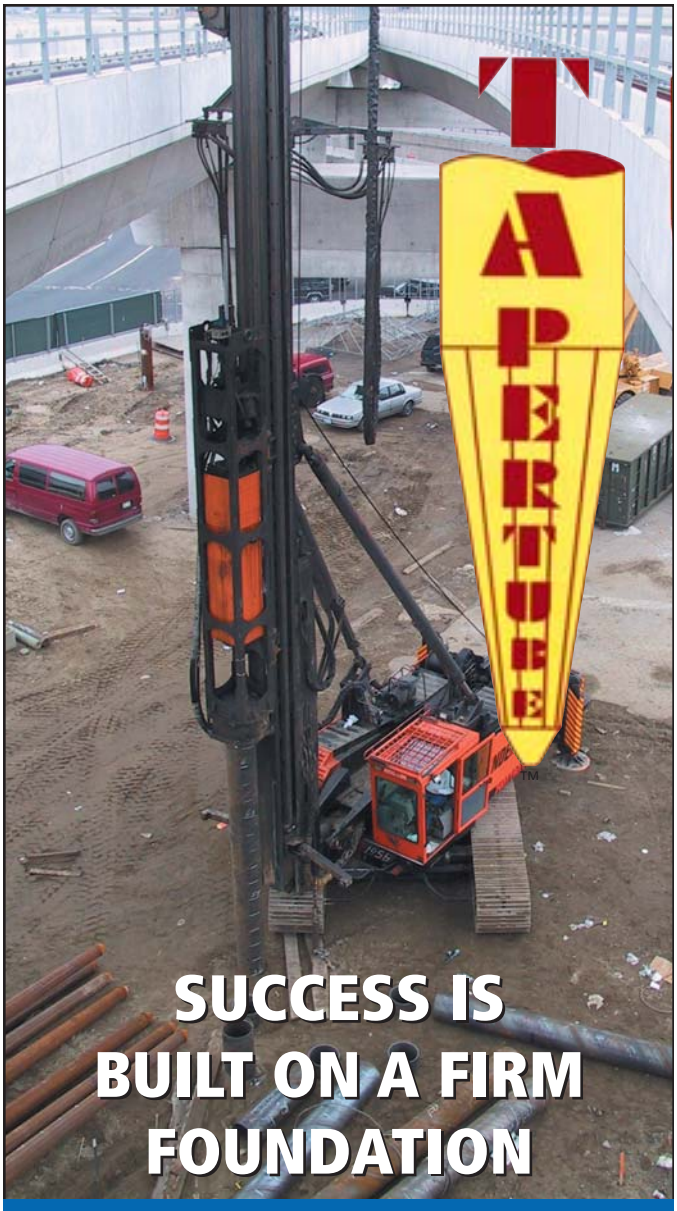
NEW ITEM!
Bullet Drill Teeth

All of our steel castings are low alloy steel. Min. yield 60 KSI.

DFP
Foundation Products, LLC

PO Box 688 • Franklin Lakes, NJ 07417-0688
201-337-5748 • fax: 201-337-9022
www.pileline.com

40 YEARS OF EXPERIENCE



Tough, trouble free, patented Tapertube piles save time, reduce costs, outperform others

DFP
Foundation Products, LLC

PO Box 688 • Franklin Lakes, NJ 07417-0688
201-337-5748 • fax: 201-337-9022
www.pileline.com

40 YEARS OF EXPERIENCE

NAYLOR PIPE PILING

For Over 80 Years, Your Direct Call or Fax To Naylor's Chicago Plant Will Give You Personalized Service Including:

- ❒ 100% domestic steel
- ❒ Exact lengths
- ❒ Attached or loose end plates
- ❒ In-plant inspection
- ❒ Conical points, chill & splice rings as required
- ❒ Mill Certification with the shipment
- ❒ Prompt availability and on time delivery of test and production pile




NAYLOR PIPE COMPANY

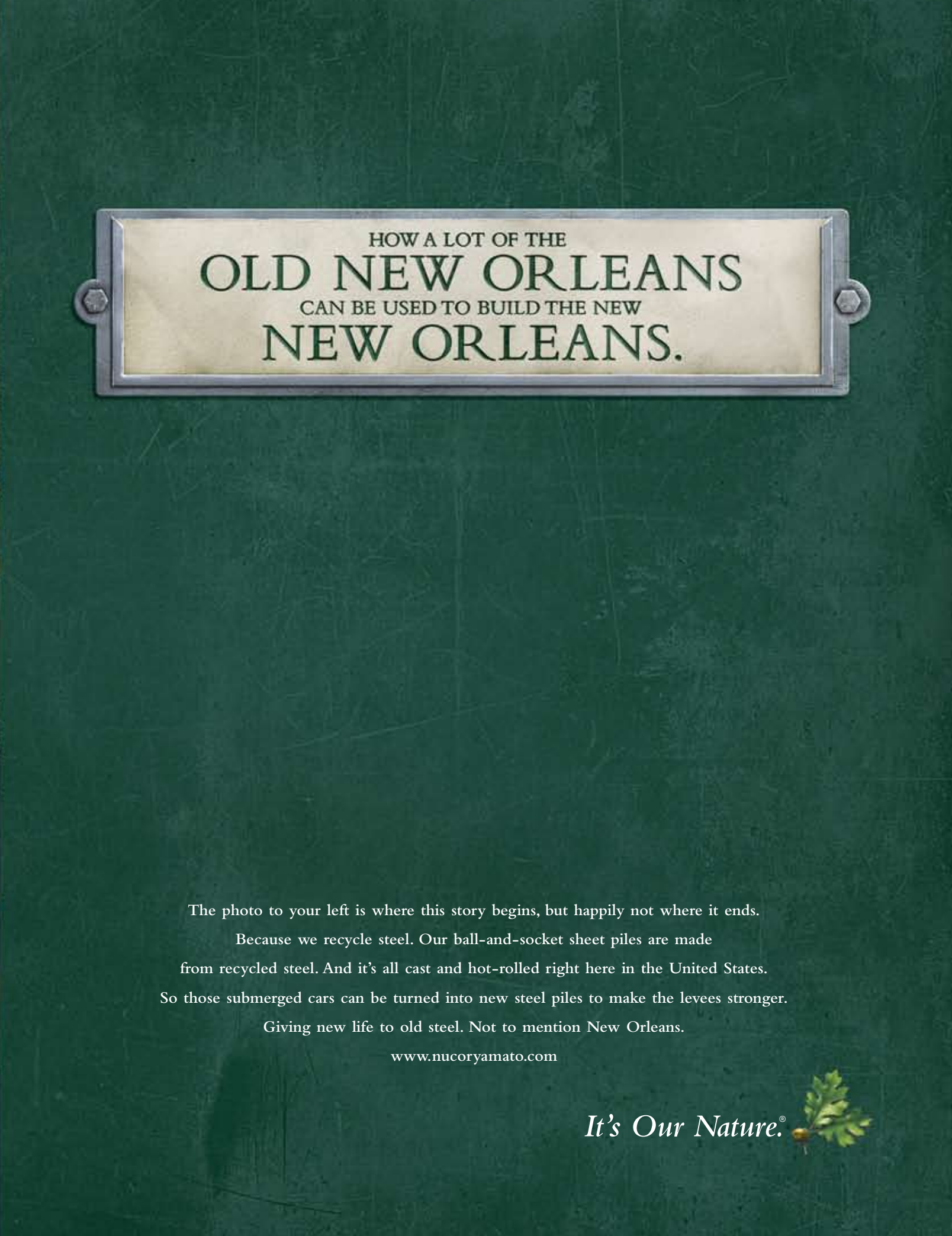
1245 East 92nd Street • Chicago, Illinois 60619

Phone: 773.721.9400 • Fax: 773.721.9494

E-mail: sales@naylorpipe.com

Visit our Website: www.naylorpipe.com

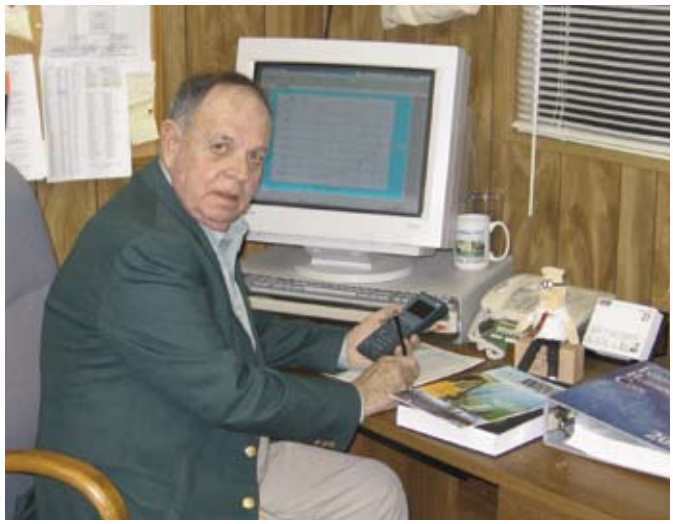

Welcome to
NEW ORLEANS
DOWNTOWN
NUCOR-YAMATO
STEEL


HOW A LOT OF THE
OLD NEW ORLEANS
CAN BE USED TO BUILD THE NEW
NEW ORLEANS.
The photo to your left is where this story begins, but happily not where it ends.
Because we recycle steel. Our ball-and-socket sheet piles are made
from recycled steel. And it's all cast and hot-rolled right here in the United States.
So those submerged cars can be turned into new steel piles to make the levees stronger.
Giving new life to old steel. Not to mention New Orleans.
www.nucoryamato.com
It's Our Nature.®

Thanks for Coming to My Life

"Thanks for coming to my life"; these are the last words written by McLeod C. Nigels, P.E. Below are some of my observations about this special man:

- Faith and Family: Mac was able to keep his life in order because his personal faith and family always came first.
- Integrity: While employed as a senior structural engineer with a large engineering firm, he took three of us from my company to lunch. Nothing unusual here. We were his customers out for a simple business meal at a cafeteria. When he paid at the checkout, he paid for his meal separate from ours. He simply did not feel right having his employer pay for his meal. Mac did what he thought was right, always.
- Responsibility: If Mac designed a foundation, by God, he designed it. Nothing halfway for him. No passing of the design buck. No hiding behind specifications boilerplate. No, sir. His plans were clear and complete. He had very little patience for members of his profession who put out incomplete plans.
- Loyalty: If you were Mac's friend, you had someone you could always count on.
- Fun: Mac had a disarming, dry wit. He loved to stick it to you in jest. Mac loved to fish. Watching Citadel baseball was his springtime love. Needling umpires was an art he admired and practiced.
- Generosity: He opened his home to Citadel cadets who were homesick. He gave them a home away from home. He paid the tuition of a Citadel student who could not afford to continue his education. If he went to the concession stand at a ballgame, he returned with an extra Coke and a bag of peanuts to share. Mac knew he might not make it until Christmas, so he had his son take him to purchase 17 pocketknives for the men working on his project. Sick as he was, he wanted to thank them for a job well done. The man simply always thought of others first. No big deal. It was just his nature.
- Innovative: Mac was conservative and loved tradition. Yet, Mac always looked to the future, seeking better ways to do things. He was always open to new ideas.
- Respect: Mac received respect because he earned it. He always showed respect to others because that is the gentlemanly thing to do. He gave respect, if you earned it.
- Humble: Mac never sought the limelight, yet he received many professional honors.



By now you may be thinking, this is unfortunate, but what does this have to do with pile driving. Mac was a true champion of the pile driving industry. Our industry does not have enough champions. His specialty was prestressed concrete pile, but he would design foundations for any appropriate type of driven pile. He questioned codes that were detrimental to driven piles and fought for correction of those codes. Mac was chairman of the PCI Committee on Prestressed Concrete Piling, responsible for the PCI report titled "Recommended Practice for Design, Manufacture and Installation of Prestressed Concrete Piling." I visited Mac less than a week before his death. Even though he could not hold his head up, he insisted that I tell him every detail of my recent trip to learn some of the European piling methods and procedures. He wanted to learn something new about pile driving.

McLeod Creighton Nigels died of complications from pancreatic cancer on October 27, 2006. A loss to all of us who knew and loved him. A loss to our industry whether we knew him or not. His passing should not go unnoticed. We need more engineers like Mac. We need more people like Mac. "Thanks for coming to my life."

Thank you for allowing me to serve as president of PDCA this past year. ▼

Committing to PDCA's Success

By Stevan Hall, PDCA Executive Director

As we proceed into 2007, I imagine we are all optimistic about the new year, and hopeful of its possibilities. The beginning of 2007 is also a good time to pause and reflect on 2006. Did we accomplish all that was expected of us? Did we reach our personal and business goals? Can we use the answers to these questions to make a greater impact in 2007 and if so, how?

As executive director, it is incumbent upon me and the board of directors of PDCA to analyze 2006 and identify areas where we excelled and brought true value to our members, and just as importantly, to identify areas where we fell short of your expectations and our objectives. The answers to these questions will help forge the goals for PDCA in 2007.

PDCA included a list of accomplishments titled, "Working On Your Behalf" when we distributed the 2007 PDCA dues invoices. This list included a compilation of distinct accomplishments or benefits/services achieved or provided by the PDCA in 2006. Some of these milestones included the formation of two new PDCA chapters; revisions to the AASHTO LRFD Bridge Installation Specifications, Section 4: Driven Pile Foundations; introduction of the Vibration and Noise Database, a new Web site; introduction of the e-letter newsletter; successful conferences and educational programs; and working jointly with other organizations to market and promote the driven pile industry, just to name a few. These accomplishments, however, would not have been possible if it were not for the participation and generous support of PDCA members throughout the year. You are the reason the PDCA had an exceptional 2006.

As we move from 2006 to 2007, it is important that I also recognize key individuals who helped make 2006 so exceptional. President Harry Robbins has done a tremendous job as your association president. Harry's vision of more local PDCA chapters has been realized as a result of his commitment to growing the PDCA. In 2006, the Mid-Atlantic and Gulf Coast chapters were formed and are well on their way to providing value at the local level, as well as being an asset to national PDCA.

Mark Weisz and Randy Dietel were both instrumental in carrying Harry's message to the leadership of the California PDCA chapter and as of this writing, the California chapter and national PDCA have agreed to a "Memorandum of Understanding" that sets the foundation for California to be the fourth PDCA chapter.

I want to thank the board of directors for their leadership and support. Additional thanks goes to the committees and chairs, including the Technical Committee (Dale Biggers, Boh Brothers), Market Development (Chair Michael Engestrom, Nucor-Yamato Steel), Environmental (Chair John Linscott, H.B. Fleming), Communications (Chair Van Hogan, Ed Waters and Sons Contracting Co, Inc.) and Finance (Chair Trey Ford, Ford Pile Foundations, Inc.). 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.

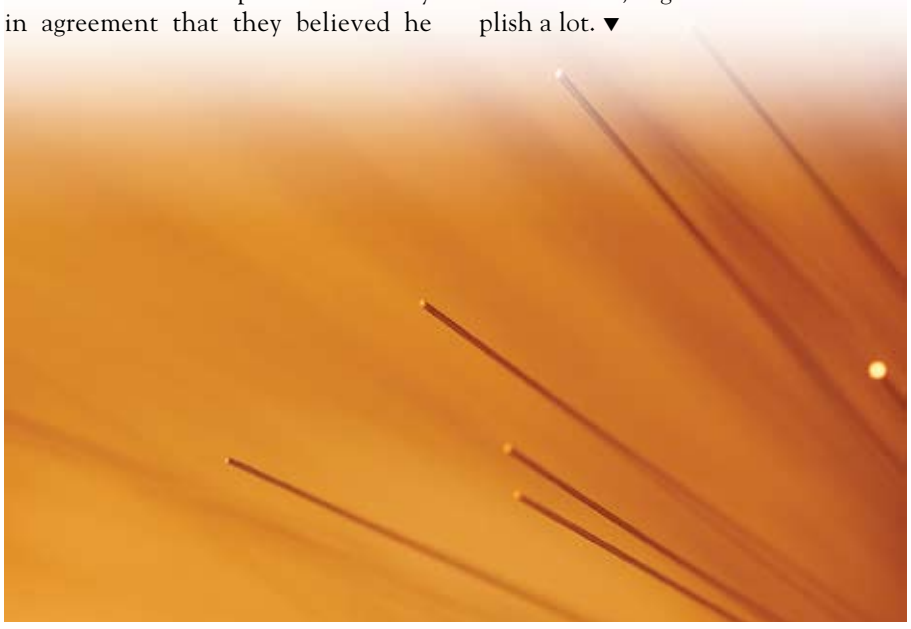
In 2007, PDCA wants to continue providing existing, as well as expanded services and benefits that create value to you and your business, as a result of your membership investment. The PDCA also wants to continue growing in 2007, just as we did in 2006 with over 40 new members. Association growth, vis-a-vis membership growth, will come in two forms: member renewals and membership development. If existing members renew in 2007, we sustain our membership levels and with each new member, we grow by one. PDCA is seeing renewals come in on a consistent basis and believes our retention in 2007 will be significant, which can be attributed to a commitment by members to promote their business, their industry, and their recognition of the value of a PDCA membership.

Membership development is everyone's responsibility. The Membership Development and Member Retention Committee, chaired by John King (Pile Drivers, Inc.), which consists of the entire board of directors, is committed to growing the association, but it takes

more than a board to make it happen. As a PDCA member, your commitment to recruiting a new member in 2007 will make a significant difference in the annual and long-term success of your association. Imagine the strength and influence your association would have with twice its current membership base, not to mention the additional service and benefits PDCA could provide its members with that kind of revenue stream.

Charles Blondin was a famous tightrope walker during the last century. He might have possibly been the best ever and was most famous for his walks over Niagra Falls, using an 1,100-foot rope. Charles has done a backwards somersault, sat on a chair, walked on stilts and, on one occasion, carried a small stove that he used to cook and eat an omelet, all while on a tightrope high above the falls. One day, after crossing the falls a number of times, he asked the crowd if they thought he could do it again. Of course the crowd responded excitedly in agreement that they believed he could make another crossing. Then, he asked one man in the crowd that if he believed, perhaps they could make the crossing together with the man from the crowd sitting in Charles' wheelbarrow. This story is about faith, but it is also about commitment. You see, you can't just be committed by mental or verbal agreement. PDCA needs your complete commitment in 2007, not just mentally or verbally, but by your actions as reflected in your membership, in recruiting new members, in your participation, and in your overall support. To commit completely will ensure the success of your association, your industry and your business. In return, your association commits to providing you with the best service and the best benefits we possibly can, throughout 2007.

I hope your 2007 is everything you hope for – and I hope part of what you wish for is a stronger, more visible, more effective association. With your commitment, together we can accomplish a lot. ▼



SUN PILEDRIVING EQUIPMENT

OFFICIAL DEALER OF JUNTTAN PRODUCTS IN THE SOUTH EASTERN USA

SUN PILEDRIVING EQUIPMENT AND JUNTTAN MAKING PROGRESS ONE PILE AT A TIME.

We Have Rigs Available In Stock For Immediate Delivery!!!

Sun Piledriving Equipment
35322 Bayard Rd.
Frankford, DE 19945
Phone:302-539-7187
Fax: 302-539-4443
Website: www.spe-usa.net
Email: info@spe-usa.net

2007 PDCA Board of Directors & Committee Chairmen

Mark Weisz
President
P: 707.562.4100
F: 707.562.4106
P.O. Box 2195
Vallejo, CA 94592
mark@csmarine.com

Van Hogan
Vice President
P: 904.823.8817
F: 904.823.9687
3375 Agricultural Center Drive
St. Augustine, FL 32092
vhogan@edwatersandsons.com

John King
Secretary
P: 843.763.7736
F: 843.763.7974
4530 Hwy. 1162
Charleston, SC 29449
kingpiledrive@aol.com

Trey Ford
Treasurer
P: 757.497.3593
F: 757.497.0031
4985 Euclid Road
Virginia Beach, VA 23462
fordpile@earthlink.net

Harry Robbins
Immediate Past President
P: 843.577.0545
F: 843.577.0547
P.O. Box 70986
Charleston, SC 29415
harry@palmettopiledriving.com

John Linscott
Director
P: 207.799.8514
F: 207.799.8538
89 Pleasant Avenue
South Portland, ME 04106
John.linscott@hbfleming.com

Rusty Signor
Director
P: 512.264.8300
F: 512.264.8301
8800 Madrone Ranch Trail
Austin, TX 78734
rustysignor@hotmail.com

Irv Ragsdale
Director
P: 301.272.8241
F: 301.272.1915
7500 Old Georgetown Road
Bethesda, MD 20814-6196
Irv.ragsdale@clarkconstruction.com

Don Dolly
Director
P: 800.841.8740
F: 925.625.5783
P.O. Box 97
Oakley, CA 94561
ddolly@foundationpile.com

Mike Elliott
Director
P: 904.284.1779
F: 904.284.2588
1058 Roland Avenue
Green Cove Springs, FL 32043
melliott@pile-eqp.net

Warren Waite
Director
P: 800.474.5326
F: 713.691.0089
P.O. Box 16099
Houston, TX 77222
wwaite@pileco.com

Richard Gilbert
Director
P: 800.433.6460
F: 678.584.9778
3250 Peachtree Industrial Blvd. Suite 203
Duluth, GA 30096
rgilbert@skylinesteel.com

Pat Hannigan
Director
P: 216.831.6131
F: 216.831.0916
4535 Renaissance Pkwy
Cleveland, OH 44128
pat@pile.com

Stevan A. Hall
Executive Director
P: 888.311.PDCA (7322)
F: 904.264.9531
P.O. Box 66208
Orange Park, FL 32065
execdir@piledrivers.org

Communications Committee
Chairman: Van Hogan
P: (904) 268-4419
F: (904) 260-9379
C: (904) 631-8309
6467 Greenland Road
Jacksonville, FL 32258
communication@piledrivers.org

Communications Committee Members:
Garland Likins, Doug Scaggs, Steve Whitty

Finance Committee
Chairman: Trey Ford
P: (757) 497-3593
F: (757) 497-0031
4985 Euclid Road
Virginia Beach, VA 23462
finance@piledrivers.org

Finance Committee Members:
Wayne Waters, Harry Robbins,
Randy Dietel, Mark Weisz.

Education Committee
Chairman: Mike Elliott
P: (904) 284-1779
F: (904) 284-2588
1058 Roland Avenue
Green Cove Springs, FL 32043
education@piledrivers.org

Education Committee Members:
Charlie Ellis, Herb Engler, Jim Frazier,
George Goble, Van Hogan, Garland Likins,
John Linscott, Rusty Signor, Gerald Verbeek.

Environmental Committee
Chairman: John Linscott
P: (207) 799-8514
F: (207) 799-8538
89 Pleasant Ave.
South Portland, ME 04106
environmental@piledrivers.org

Environment Committee Members:
Bud Abbott, Jim Bay, Chuck Blakeman,
Gordon Boutwell, Ed Hajduk,
Garland Likins, Mark Miller, Mark Svinkin,
Joe Savarese, Barry Roth, Warren Waite

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

Market Development Committee Members:
Dean Abbondanza, Stan Baucum,
Cliff Bengston, Dave Harper,
Dean Mathews, Scott Whitaker,
Max Williams

Membership Development Committee
Chairman: John King
P: (843) 763-7736
F: (843) 763-7974
4530 Hwy 162
Charleston, SC 29449
membership@piledrivers.org

Membership Committee Members:
Harry Robbins, Mark Weisz, Van Hogan,
Randy Dietel, Mike Elliot, Richard Gilbert,
Garland Likins, John Linscott
and Warren Waite

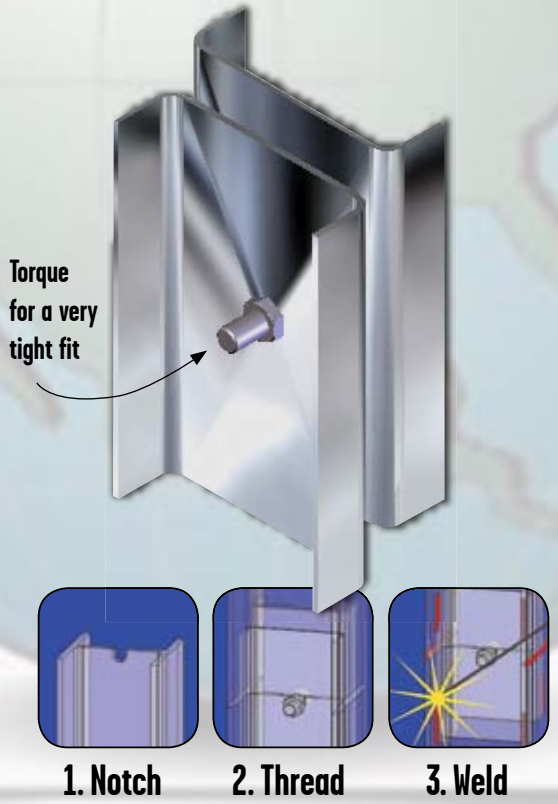
Technical Committee
Chairman: Dale Biggers
P: (504) 821-2400
F: (504) 821-0714
P.O. Drawer 53266
New Orleans, LA 70153
technical@piledrivers.org

Technical Committee Members:
Dan Brown, Joe Caliendo, Charlie Ellis,
Jim Frazier, George Goble, Van Komurka,
Garland Likins, John Linscott,
James H. Long, Dean Matthews,
Joe Phillips, D.S. "Sax" Saxena,
Gerald Verbeek, Scott Whitaker.

GET CONNECTED

with Versa Steel's Adjustable Bolted Splicer

Our splicer bolts tight and allows for faster welding and cost savings on the job site.



1. Notch 2. Thread 3. Weld

Tighter fit means enhanced load value. Rotate one side to make assembly staggered for easy threading. One size fits all foot weights. To learn more call:

VERSA-STEEL
PILING ACCESSORIES

1-800-678-0814

Phone (503) 287-9822 Fax (800) 287-7483
www.PileTips.com sales@versasteel.com
US Pat Pending #778,181

FLORIDA PIPE & STEEL INC.

OD	Wall	WT / FT	Footage
9.625	.395	38.938	1,800
9.625	.472	46.14	2,800
9.625	.545	52.851	3,185
10.750	.400	44.215	6,000
10.750	400	44.215	4,200
11.750	.375	45.557	18,500
11.750	.480	57.775	5,600
11.750	.534	63.966	4,200
11.800	.582	69.728	8,500
12.750	.375	49.562	11,250
13.375	.480	66.105	12,400
13.375	.514	70.601	4,400
13.375	.625	85.106	8,800
13.800	.625	87.943	6,600
16.000	.485	80.365	2,300
16.000	.500	82.770	750
16.000	.566	93.297	750
16.000	.575	94.725	2,600
18.000	.500	93.45	6,200
20.000	.500	104.13	6,100

- New & Used Steel Pipe
- Structural Steel Pipe
- Fabrication To Length
- Coating, Points & Plates
- Mill Rollings

With stocking locations in Texas, Florida, Alabama , Ohio and Oklahoma let us be your "one stop" source for Steel Pipe!

Phone: 800-823-3436
Fax: (561) 642-7438
E-mail: sales@floridapipe.com

Committee Corner

In this issue, we highlight the work of Mike Elliott of Pile Equipment, Inc. in Green Cove Springs, Fla., who is a PDCA Director, and Chair of the Education Committee.

I have been in the pile driving industry since 1972, and am currently the president and co-owner – with my partner, Mark Rutland – of Pile Equipment, Inc., which we started in January 1987. Pile Equipment, Inc. rents, sells and services pile driving equipment in the southeast United States.

Among my responsibilities at Pile Equipment, I teach courses in the pile driving industry. Most recently, I taught the S.C. DOT hammer school, ASCE hammer presentation, Coast Guard Education of Equipment Usage, and Customer Schools. I have also served on the FL. D.O.T. 455 Review Committee. Presently, I am working with the University of Florida, teaching the Pile Inspectors course throughout the state.

The PDCA Education Committee is challenged with the responsibility of oversight and coordination of the association's annual conference and the Design and Installation of Cost Efficient Piles (DICEP) conferences.

Currently, I am working with the Education Committee members on the 11th Annual PDCA International Conference and Exposition. I am excited about this year's conference and the new format, which is intended to provide not only excellent educational programs, but also more social time and an opportunity to enjoy the company of fellow pile drivers.

The Education Committee is also working on the production of a PDCA video. A request for video from our members has already been circulated and submittals have been received on a variety of topics. The Education Committee is also working with the Federal Highway Administration (FHWA) to produce a "webinar" (web-based education program) on the advances in pile driving equipment since the turn of the century.

PDCA
PILE DRIVING CONTRACTORS ASSOCIATION

THE PILE DRIVING CONTRACTORS ASSOCIATION

11th ANNUAL INTERNATIONAL CONFERENCE AND EXPOSITION

GAYLORD OPRYLAND RESORT AND CONFERENCE CENTER

NASHVILLE, TENNESSEE
MARCH 28 – 31, 2007

SPECIAL EVENTS	
Wednesday, March 28	• Pre-Conference Course – Deep Foundations Design Construction & Quality Control
Thursday, March 29	• 1st Annual PDCA Golf Tournament Gaylord Springs Golf Links • Companion's Program – Tour of the Ryman Auditorium, Lunch at the Wild Horse Saloon, Music and Line Dancing Instructions at the WildHorse Saloon • PDCA Annual Dinner Country-Western Theme Dress and Dance featuring *Justin Barrett and the Usual Suspects*
Friday, March 30	• Round Table Discussion–*Evolving Specifications* and Design Criteria and their Impact on Driven Pile Costs • Hammer Manufacturers Forum – Featuring PDCA Member Hammer Manufacturers • Companion's Program–General Jackson Showboat • Grand Ole Opry

DAILY AGENDA

WEDNESDAY, MARCH 28

7:00 AM
- Registration–Pre-Conference Course
- ContinentalBreakfast

8:00 AM
- Pre-Conference Course: Deep Foundations: Design, Construction & Quality Control, Instructors: Jerry DiMaggio/Peter Osborn, US DOT, FHWA

10:00 AM
- Morning Break

12:00 Noon
- Lunch for Pre-Conference Course

1:00 PM
- PDCA Committee Meetings
- Exhibitor Set-Up Opens
- Early Arrival Annual Conference Registration Opens

3:00 PM
- Afternoon Break–Exhibit Hall

5:30 PM
- Reception–Exhibit Hall–Pre-Conference Attendees and Early Arrivals

7:30 PM
- Board of Directors & Committee Chairs Dinner

THURSDAY, MARCH 29

7:00 AM
- Continental Breakfast–Exhibit Hall
- Annual Conference Registration Opens

8:00 AM
- Annual Conference Presentations Begin
  8:00 AM – 8:50 AM
  9:00 AM – 9:50 AM

9:00 AM
- Companion's Program Continental Breakfast 8:45 AM - Meet in Governor's Ballroom Lobby for escort to Presidential Suite

10:00 AM
- Morning Break–Exhibit Hall

10:15 AM
- Annual Conference Presentations–Continued
  10:15 AM – 11:00 AM
- Companion's Program–Tour of the Ryman Auditorium(Original Grand Ole Opry)

11:30 AM
- Companion's Program–Walk to Wild Horse Saloon

12:00
- Noon Lunch followed by Music and Line Dancing with an Instructor
- 1st Annual PDCA Golf Tournament–Gaylord Springs Golf Links bus transportation provided to course– Special Event–Requires advanced registration

7:30 PM
- PDCA Annual Dinner with Country-WesternTheme/Dress *Justin Barrett and the Usual Suspects Band, Line Dance Instructor and dancing*

FRIDAY, MARCH 30

7:00 AM
- Continental Breakfast–Exhibit Hall

8:00 AM
- Round Table Discussion–*Evolving Specifications and Design Criteria and Their Impact on Driven Pile Costs*

9:00 AM
- Companion's Program–Continental Breakfast 8:45 AM - Meet in Governor's Ballroom Lobby for escort to Presidential Suite

9:30 AM
- Morning Break–Exhibit Hall

10:00 AM
- Hammer Manufacturers' Forum

10:30 AM
- Companion's Program–General Jackson Showboat Mid-Day Cruise, Lunch and Theater Show

12:30 PM
- Lunch, Project of the Year Award, Committee Chair Awards, Golf Tournament Awards

2:30 PM
- Executive Committee Meeting

5:00 PM
- Reception–Exhibit Hall

7:30 PM
- Grand Ole Opry–Special Event –Requires advanced registration and ticket purchase

SATURDAY, MARCH 31

7:00 AM
- Continental Breakfast – Exhibit Hall

8:00 AM
- Annual Conference Presentations
  8:00 AM – 8:50 AM
  9:00 AM – 9:50 AM

10:00 AM
- Morning Break–Exhibit Hall

10:15 AM
- Annual Conference Presentation
  10:15 AM – 11:00 AM
- PDCA 11th Annual International Conference and Exposition Concludes

12:30 PM
- Board of Directors Meeting

EVENT DETAILS

Deep Foundations: Design, Construction and Quality Control (Pre-Conference Course)

Cost:
PDCA Members, Government Employees, ASCE Members - $290.00 All Others - $375.00
Pre-registration required. Include payment with Conference Registration

Instructors:
Jerry DiMaggio, FHWA, Peter Osborn, US DOT, FHWA, Washington, DC

Date:
Wednesday, March 28, 8:00 AM–5:00 PM

PDH:
8 PDHs towards Engineering License Renewal–Dept. of Commerce and Insurance, Tennessee State Board of Architectural and Engineering Examiners and States with Tennessee reciprocity.

Purpose and Background:
The purpose of this course is to present modern techniques for the design, installation and verification of deep foundations. Over the past twenty-five years, major changes have occurred in the deep foundations industry. For driven piles, higher loads can be achieved with new hammers, dynamic quality control methods have been adopted, wave equation analysis is being widely used, and higher strength materials are becoming common.

Seminar Benefits:
Find out the latest subsurface investigation methods for deep foundations, understand the design process for deep foundations, learn new procedures for the design and installation of deep foundations, learn the use of wave equation analysis as applied to both the design and installation of driven piles including driving problems, and understand various capacity determination methods including static and dynamic methods. Each participant will receive the FHWA's comprehensive two-volume manual set, "Design and Construction of Driven Pile Foundations."

Who Should Attend:
Geotechnical Engineers, construction engineers, contractors, owners, structural engineers, or any professional involved in the design, construction, inspection, testing and specification of deep foundations.

PDCA 1st Annual Golf Tournament –Gaylord Springs Golf Links

Cost:
$120.00 per player.
Include payment and golfer information with Conference Registration

Date:
Thursday, March 29, 1:00 PM Shotgun Start
(Lunch served before start)

Format:
Four-person team scramble (Captain's Choice) with handicaps – 26 maximum allowed.

Includes:
Transportation to the course, lunch at the Clubhouse, golf, cart, driving range, Goodie Bag, free drinks on the course with drink tickets (provided by PDCA), prizes for Closest-to-the-Hole, and Long Drive

Teams and Awards:
You do not need a foursome to enter – Singles, etc. welcome. First Place Low Gross, Low Net and Worst Team. Maximum handicap allowed–26. Awards presented during the Friday, March 30 luncheon.

Rental Clubs:
Club rental is available at a fee of $40.00 per rental set. The Gaylord Springs Golf Links offers Callaway X-18s for men and women. Club rental must be designated on the registration form and paid for submitting registration fees.

Dress Code:
Appropriate golf attire required. Collared shirts are required. Shorts must be Bermuda length, no t-shirts, tank tops, cut-offs, sweat pants, bathing suits, athletic shorts or denim permitted. The Gaylord Springs Golf Links is a soft spikes only facility.

Grand Ole Opry

Cost
$50.00 per person
Include number of tickets and payment with Conference Registration

Date:
Friday, March 30, 7:30 PM
What began as a simple radio broadcast from Nashville, Tennessee, is today one of the true icons of American entertainment. The Grand Ole Opry showcases the best in country music from new stars, superstars and legends live on the Opry stage. The Grand Ole Opry blends the excitement of a live audience, the heritage of the world's longest-running live radio show (first aired in 1925), and an incredible mix of country music talent to create a uniquely American experience like no other.

Companion's Program: Sponsored by Piling, Inc.

Bring your Companion or Guest to this year's Annual Conference. They are sure to enjoy the sites, scenery, and shopping Nashville offers. PDCA has a variety of entertaining programs scheduled for registered Companions and Guests, which include the following:

Presidential Suite	Continental Breakfast	Thr./Fri. March 29, 30
Ryman Auditorium	Tour	Thursday, March 29
Wild Horse Saloon	Lunch	Thursday, March 29
Wild Horse Saloon	Line Dancing w/Instructor	Thursday, March 29
General Jackson Showboat	Cruise, Lunch, Show	Friday, March 30

The Companion's Program also includes all Conference Receptions and Annual Dinner.

Hammer Manufacturers' Program
The PDCA will conduct a Hammer Manufacturers' Forum on Friday, March 30. All Hammer Manufacturers who are members of the PDCA are invited to participate in this unique forum. Participating Manufacturers will be given approximately 15 minutes to describe their hammer's unique features, design capabilities, driving capabilities, production and environmental benefits and overall specifications. This will be followed by a brief Q&A period. The forum will be facilitated by a moderator. Manufacturers participating in the forum must be PDCA members, registered Exhibitors at the conference, and pay an additional $100.00.

Round Table Discussion–Evolving Specifications and Design Criteria and Their Impact on Driven Pile Cost
The PDCA will conduct a Round Table discussion on evolving specifications and design criteria and the impact they have on the cost of driven pile projects. Are more complicated and intricate specifications and over designed projects having a negative impact on driven pile costs to the contractor and owner; or do project advancements require more sophisticated specifications and designs. Attend this discussion and hear what the expert panelist have to say, while voicing your own opinion.

CONFERENCE TOPICS AND SPEAKERS

Topics listed below are confirmed presentations. Other selections are pending and will be added upon review and approval by the PDCA Education Committee.

CONFERENCE PARTICIPANTS RECEIVE 6 PDHs FOR ATTENDING ALL PRESENTATIONS

Developments in Deep Foundation Highway Practices– The Last Quarter Century Jerry DiMaggio, US DOT, Federal Highway Administration, Washington, DC

This presentation examines the many significant changes in deep foundation design and construction within the United States highway practice during the last quarter century. The impressive listing of advancements has resulted in numerous benefits to the professional community, the deep foundation industry, and to the United States taxpayers, as well as private owners. The benefits have been tangible and intangible, and include reduced total project cost, accelerated speed of construction, development and deployment of improved materials and construction equipment, improved specifications and contracting procedures, and an overall improved appreciation of Geotechnical Engineering within the highway industry. In-depth comparisons are made between current practice, national practice circa 1980, and 20 years in the future (2026).

Hammer Types, Efficiencies and Models in GRLWEAP Anna Klesney and Frank Rausche, GRL Engineers, Inc. and Liaun Liang, Pile Dynamics, Inc.

It seems as though almost every day a new hammer model enters on the market in the United States. Sometimes the new models are nearly identical with existing ones. Sometimes completely new hammers are being developed. In order to perform wave equation analyses certain hammer parameters must be obtained from the manufacturer and then coded into the hammer data file. Other parameters, such as the efficiency of the hammer or the maximum combustion pressure of diesel hammers have to be calculated. This paper gives an overview over the various hammer models stored in the GRLWEAP data file, their efficiencies and differences. The paper explains why the results of some of these hammers differ even if they appear to be almost identical. It also demonstrates the procedure of converting the basic hammer information to the pile model parameters that are then entered in the data file. A few examples will be given.

Update on Seismic Provisions for Precast / Prestressed Piles Timothy Mays, Professor, Civil and Environmental Engineering Department, The Citadel

Spiral requirements for precast prestressed piles in areas of high seismicity have changed significantly over the past 20 years. Most codes and standards specify a minimum volumetric ratio of spiral that is a function of the applied axial load, material properties, and geometric configuration of the pile. Research to date has focused on large dimensional piling (i.e., greater than 15 in. diameter) and code committees have too conservatively extrapolated these results for 10 in., 12 in., and 14 in. square piles. This paper summarizes the evolution of ductility design provisions for precast prestressed piling used for bridges and buildings in areas of high seismicity and concludes that current standards provide no rational basis for their provisions. Based on a proposed target curvature ductility value of 20, the results of a comprehensive parametric study of over 2,500 pile configurations is also presented and a simple design equation is proposed for 10 in., 12 in., and 14 in. square piles. The results of this paper are being used by the Structural Engineers Association of South Carolina to propose a code change to the 2003 International Building Code that will allow design engineers to specify spiral quantity using performance based design procedures for precast prestressed piling in South Carolina.

Steel H-Section Pile Support, New Penobscot Narrows Bridge, Verona Island and Prospect, Maine James W. Weaver, P.E., Haley & Aldrich

One of the massive pylon foundations at the recently completed 2,120-foot long cable stayed Penobscot Narrows Bridge in Maine is supported on 288, 215-ton design capacity steel H-section piles (HP 14X117, 50 ksi steel). The piles were driven through over 100 feet of dense granular soils containing cobbles and boulders up to 3 feet in diameter. The piles were driven by Cianbro/Reed & Reed, LLC using a Delmag D62-22 single acting diesel hammer. Twelve representative piles were selected for dynamic testing (ASTM D4945) and the testing determined that four different pile driving criteria were required because of variation in the bedrock surface depth and soil resistance within the plan area of the foundation.

The foundation was originally designed be supported on high capacity rock-socketed drilled shafts, due in part to the uncertainties associated with installing closely spaced steel piles through dense soils containing cobbles and boulders. Cianbro/Reed & Reed, LLC contended that the steel piles could be installed at a lower coast and in a shorter time period. The contractor's proposal was reviewed and accepted, and the piles were successfully installed. The presentation will summarize the design and construction of the Verona Pylon foundation.

Under-Tunneling of a Railroad Dam Herman Zeilinger

One of the most frequent railroad links between Frankfurt and Nuremburg had to be under tunneled in a section where the railroad crosses a valley on top of a dam 20 meters above ground. The original design proposed a local deviation, on a parallel running causeway requiring traffic interruptions at several times. The new design goal was to eliminate the proposed deviation dam and bridge and keep railroad traffic going wit no interruptions.

In a first phase, a steel sheet piling wall was installed on both sides of the dam covering the section of the tunnel with the later wing walls. Setting up the double piles, placing the hammer on top directly above high voltage electrical power lines was not an easy job. Because of some extremely dense soil layers driving was more difficult than expected. The two parallel walls were anchored together keeping the earth structure of the dam stable all time. The rail road traffic was never interrupted during the driving operations.

The second phase objective was to construct a circular protection screen through the dam. To build this cylindrical screen, steel pipes of 4 foot in diameter were driven horizontally through the dam using a compressed air powered soil rocket. All pipes were driven in a circular design and connected together by welds on sheet piling interlocks. Additionally the pipe structure was reinforced by concrete rings installed on both end.

In the third phase, the final tunnel was constructed in sections as monolith concrete circles outside of the screen and later hydraulically moved into their correct position. The mouth of the tunnel and the wing walls were cast in place. The space between the steel pipes and the tunnel was filled with liquid cement emulsion.

EXHIBITORS

Exhibitor opportunities are available during the conference. All exhibitors will be located in the Gaylord Opryland Resort and Conference Center adjacent to the presentation ballroom. All continental breakfasts, AM and PM conference breaks, receptions, and luncheons will be conducted in the exhibit area, increasing the traffic to all exhibitors.

The exhibit area will accommodate 39 exhibitors in 10' x 10' booths. Each booth will have an 8' high back wall with a 3' high side

drape, 7" x 44" one-line ID sign, one 6' x 30" draped table, 2 side chairs and one lined waste basket. Electricity and A/V needs will be available upon request. *Booth selection will be made by the exhibitor once the company registers.* Exhibitors will receive one main conference registration with the reservation of a booth. Freeman will provide information on shipping and storage. That information will be provided to you on the PDCA website as a direct link to Freeman and our conference.

THE GAYLORD OPRYLAND RESORT AND CONFERENCE CENTER

PLEASE MAKE YOUR RESERVATIONS EARLY

Gaylord Opryland is recognized around the world for its extraordinary service, luxurious accommodations and first-class entertainment. Under majestic, climate-controlled glass atriums, you'll be surrounded by nine acres of lush indoor gardens, winding rivers and pathways, and sparkling waterfalls where you can unwind, explore, shop, dine, and be entertained to your hearts content. Highlights include a 44-foot waterfall, laser-light and fountain shows, and tours aboard the Gaylord's Delta Flatboats–right inside the hotel. The Gaylord also features, Relache–The Spa at Gaylord Opryland, where you can indulge yourself with unparalleled treatments and programs. This world-class spa, state-of-the-art fitness center and salon features 12 enchanting treatment rooms dedicated to pampering, peace and renewal. Your room fee also includes high-speed internet access, local and toll-free calls up to 20 minutes, access to Cyber Café', access to the fitness center, USA Today delivered to your room (Monday–Friday), 2 bottles of water (refreshed daily) and scheduled complex transportation.

PDCA has secured a special room rate of $175.00 per night, Single or Double, including the resort fee. On an optional basis and based on availability, you can upgrade to an Atrium View room for an additional $30.00 per night. *Reservations must be made individually*, by calling 1-866-972-6779, and using the following code: Pile Driving Contractors Association Group or Group Code *X-PILE*. The room rate will be available three (3) days prior to and three (3) days following the conference dates on a space available basis. Reservations must be made by Monday, March 5, 2007, to be guaranteed at the special room rate for the conference. Reservations made after this date will be on a space available basis only and cannot be guaranteed.

SPECIAL NEEDS

Anyone requiring special needs of any kind should contact the PDCA office. All inquiries should be addressed to the PDCA office, toll-free at 888.311.PDCA (7322).

Travel Assistance:

For help with your travel arrangements, contact PDCA Travel Coordinator,
Lorraine Engelman, Blue Ribbon
Travel by phone at (718) 767-5455
or (917) 680-3108 or email at:
lorraine@blueribbon.travel

Child Care Services:

The Gaylord Opryland Resort and Conference Center offers professional child care on an hourly or daily basis. For more information, please contact the PDCA office, toll-free at 888.311.PDCA (7322).

COOPERATING ORGANIZATIONS

The PDCA would like to acknowledge the following cooperating organizations:

U.S. Department of Transportation
Federal Highway Administration

GEO INSTITUTE
of the American Society of Civil Engineers

SPONSORSHIP OPPORTUNITIES

The PDCA is seeking sponsors in the categories listed below. If you or your firm is interested in helping the PDCA make the conference a truly special event with a financial contribution, please indicate your level of sponsorship on the registration form.
Sponsorships include:

- Platinum–One conference registration, one golf registration, two tickets to the Grand Ole Opry, acknowledgment at the Annual Dinner, and name displayed through out the conference.
- Gold–One conference registration, acknowledgment at the Annual Dinner, and name displayed throughout the conference.
- Golf–One golf registration, name displayed at the Gaylord Springs Golf Link during play, name displayed throughout the conference, and acknowledgment at the Annual Dinner.
- Golf Hole–Sponsors a hole on the Gaylord Springs Golf Links during PDCA tournament play.
- Annual Dinner–Sponsors the Annual Dinner and Band with name displayed at the Annual Dinner, acknowledgment at the Annual Dinner, and name displayed throughout the conference.
- Receptions–Sponsors all three receptions, name displayed at the receptions and throughout the conference, acknowledgment at the Annual Dinner.
- Continental Breakfasts–Sponsors all four continental breakfasts, name displayed at the Continental Breakfasts and acknowledg ment at the Annual Dinner.
- AM and PM Breaks–Sponsors all five conference breaks, name displayed at the Breaks and acknowledgment at the Annual Dinner.

Experience the Progress.

Liebherr Nenzing Crane Co.
7075 Bennington Street
Houston, TX 77028-5812
Phone: +1 713 636 4050
Fax: +1 713 636 4051
www.liebherr.com

LIEBHERR
The Group

REGISTRATION AND SPONSOR INFORMATION

Pre-Conference Course: Deep Foundations: Design, Construction & Quality Control
PDCA Members, Government Employees, ASCE Members ..... $ 290.00

Pre-Conference Course: Deep Foundations: Design, Construction & Quality Control
All Others ..... $ 375.00

Conference Registration:
PDCA Members, Government Employees, ASCE Members ..... $ 545.00

Early Bird Conference Registration (Prior to March 9, 2007):
PDCA Members, Government Employees, ASCE Members ..... $ 495.00

Conference Registration–
All Others ..... $ 595.00

Early Bird Conference Registration (Prior to March 9, 2007)–
All Others ..... $ 545.00

Companion's Program–Conference Registration ..... $ 175.00

Companion's Program–Early Bird Conference Registration $150.00

Students Enrolled in Engineering Programs ..... $ 150.00

Children (under the age of 18) ..... Free

Exhibitors (Includes One Conference Registration):
PDCA Members, Government Employees, ASCE Members ..... $ 900.00

Exhibitors–(Includes One Conference Registration)–
All Other ..... $ 1200.00

Manufacturers Forum (Must be an Exhibiting PDCA Member) ..... $ 100.00

Golf Tournament–Gaylord Springs Golf Links, Thursday, March 29 ..... $ 120.00

Grand Ole Opry–Friday, March 30 ..... $ 50.00

SPONSORSHIP FEES

Platinum	$ 2500.00
Gold	$ 1500.00
Golf	$ 500.00
Golf Hole	$ 100.00
Annual Dinner	$ 1000.00
Reception	$ 1000.00
Continental Breakfast	$ 500.00
AM and PM Breaks	$ 400.00

REGISTRATION INFORMATION

Registration Forms must be completed fully and submitted to the Pile Driving Contractors Association, P.O. Box 66208, Orange Park, FL. 32065, with a check or credit card information before registration can be completed. Registration can be made via fax to the PDCA office at 904.264.9531, providing all registration and payment information is completed on the Registration Form.

Please print clearly or type all information on the Registration Form. If submitting credit card information, all information on the Registration Form must be filled out clearly and completely for PDCA to process your registration. Incomplete information will delay registration.

All inquires should be addressed to the PDCA office, toll-free at 888.311.PDCA (7322).

REGISTRATION FORM

SECTION I: Company Information:

Company Name _____
Address _____
City, State, Zip _____
Email _____ Phone _____

SECTION II: Registration Information

Pre-Conference Course: Deep Foundations: Design, Construction & Quality Control

Pre-Conference Registration	_____	X	$290.00	_____
Pre-Conference Registration All Others	_____	X	$375.00	_____
Conference Registration:				
Conference Registration	_____	X	$545.00	_____
Early Bird Registration	_____	X	$495.00	_____
Conference Registration All Others	_____	X	$595.00	_____
Early Bird Registration All Others	_____	X	$545.00	_____
Companion's Program	_____	X	$175.00	_____
Companion's Program Early Bird	_____	X	$150.00	_____
Student Conference Registration	_____	X	$150.00	_____

TOTAL _____

Name _____ Name _____
Name _____ Name _____

SECTION III: Exhibitor Information (Includes One Conference Registration)

Exhibitor	_____	X	$900.00	_____
Exhibitor: All Others	_____	X	$1200.00	_____
Manufacturers Forum	_____	X	$100.00	_____

TOTAL _____

Manufacturers Name _____
Electricity ____ Y ____ N A/V ____ Y ____ N Item Needed _____
Exhibitor's Representative _____

SECTION IV: Golf Registration

Player I _____ Player II _____
Player III _____ Player IV _____
Player's Hdcp: I _____ II _____ III _____ IV _____ Rental Clubs – RH _____ LH _____

Golf Registration	_____	X	$120.00	_____
Rental Clubs	_____	X	$ 40.00	_____

TOTAL _____

Yes, we will contribute to the Goodie Bag (Item): _____

SECTION V: Grand Ole Opry

Grand Ole Opry Tickets	_____	X	$ 50.00	

TOTAL _____

SECTION VI: Sponsors

_____ Platinum - $2500.00
_____ Annual Dinner and Band - $1000.00
_____ Golf - $500.00
_____ Continental Breakfast - $500.00
_____ Gold - $1500.00
_____ Receptions - $1000.00
_____ Golf Hole - $100.00
_____ AM & PM Breaks - $400.00

TOTAL

SECTION VII: Payment Information

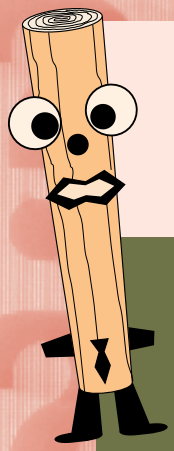
Payment Method: _____ Check (Enclosed) ____ Visa ____ MC ____ AMX
Exp. Date _____ Code # _____ Card Number _____
Statement Billing Address _____
City, State, Zip Code _____
Name on Card _____ Signature _____

GRAND TOTAL FROM ALL SECTIONS

PDCA
PILE DRIVING CONTRACTORS ASSOCIATION

Return The Completed Registration Form And Your Payment To

PDCA
P.o. Box 66208,
Orange Park, Florida 32065
Or Fax Registration Form And Payment Information To
904-264-9531



Did You Know?

In this new department the PDCA asks "Did you know...?" and provides quick facts and tips of use to members.

Dynamic monitoring provides information about the pile installation on a wide variety of results.

In addition to estimating ultimate load bearing capacity at the time of testing (e.g. during driving, or during re-strike to include "set-up"), other "benefits" include monitoring compression and tension stresses during driving, evaluating pile integrity, and monitoring hammer performance.

The Roman Circus at Arles

Archaeologists in Arles, France uncover a fascinating use of driven piles in the Ancient Roman Empire

By Hermann Zeilinger

Introduction

A visitor in the year 2000 strolling through Arles, the ancient Provencal Capital, will see the same monuments, buildings and places as his friend in spirit eighteen hundred years ago. He will walk along the Roman fortification, the theater and the amphitheater before reaching the museum.

The Hippodrome

Just in front of the museum, the visitor may recognize an excavation, half-circled by a retaining wall. Below that wall, some stone structures show the symmetrically arranged pattern of an ancient foundation of a lost building. The concrete wall marks the circle of the hippodrome, the poor remains of a stadium for 20,000 spectators.

There is not much to see, but the reconstructed model of the hippodrome shows a very sophisticated foundation system.

The Topic

The reconstruction of the circus was like solving an incomplete puzzle. The archeological excavations supplied the data to determine the size and shape of the circus and disclosed a pattern of driven piles, a very suitable foundation system.

This report concerns the soil conditions and specific problems the Roman engineers had to solve, to create the required bearing capacity for the heavy weight structure. The results of the archeological investigation afford an insight into the planning, testing and execution of their design.

With the method of Dendrology, the age of the wooden material was determined: all piles checked were cut in the winter of A.D. 148 to 149, during the reign of Emperor Antoninus Pius.

The Design of the Circus in Arles

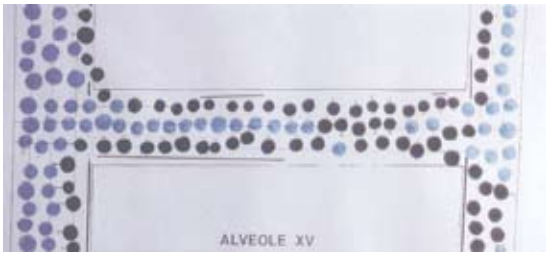
Selection of the Site and Infrastructure

The people of Arles wanted a circus, a hippodrome for chariot races and other events. The idea needed the support of the political power and the imperial administration. We guess financing and design started years before the project got the final permit of Caesar Antoninus Pius and any funding from Rome before the cornerstone was set.

We do not have any historical documents. We know only what the archeologists were able to determine: the location and the size of the circus with numbers of seats, and the year A.D. 148 – the year the trees for the piling were cut.

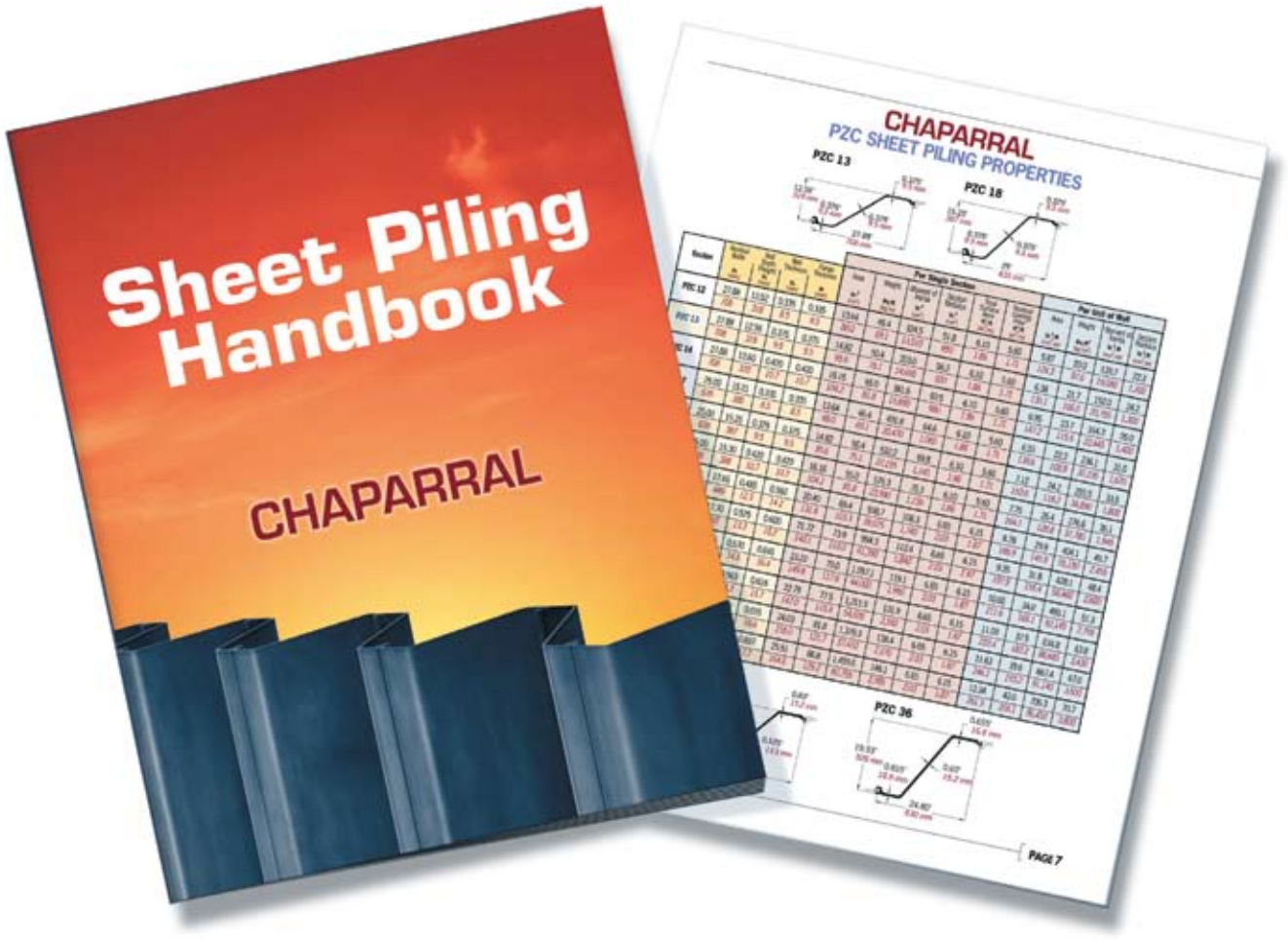
The map of ancient Arles shows us where the building was finally placed: just outside of the city to the south and parallel to the river less than half a mile from the forum. Even from the other quarters the hippodrome was still within walking distance.

Arles, itself was not big enough to fill a stadium with 20,000 seats, but the Rhone River offered very convenient access to all people living along both sides of the river. Arles and the games attracted people from communities several days' journey away. The road condi-



Reconstruction of the piling system

CHAPARRAL HAS RE-WRITTEN THE BOOK ON SHEET PILING



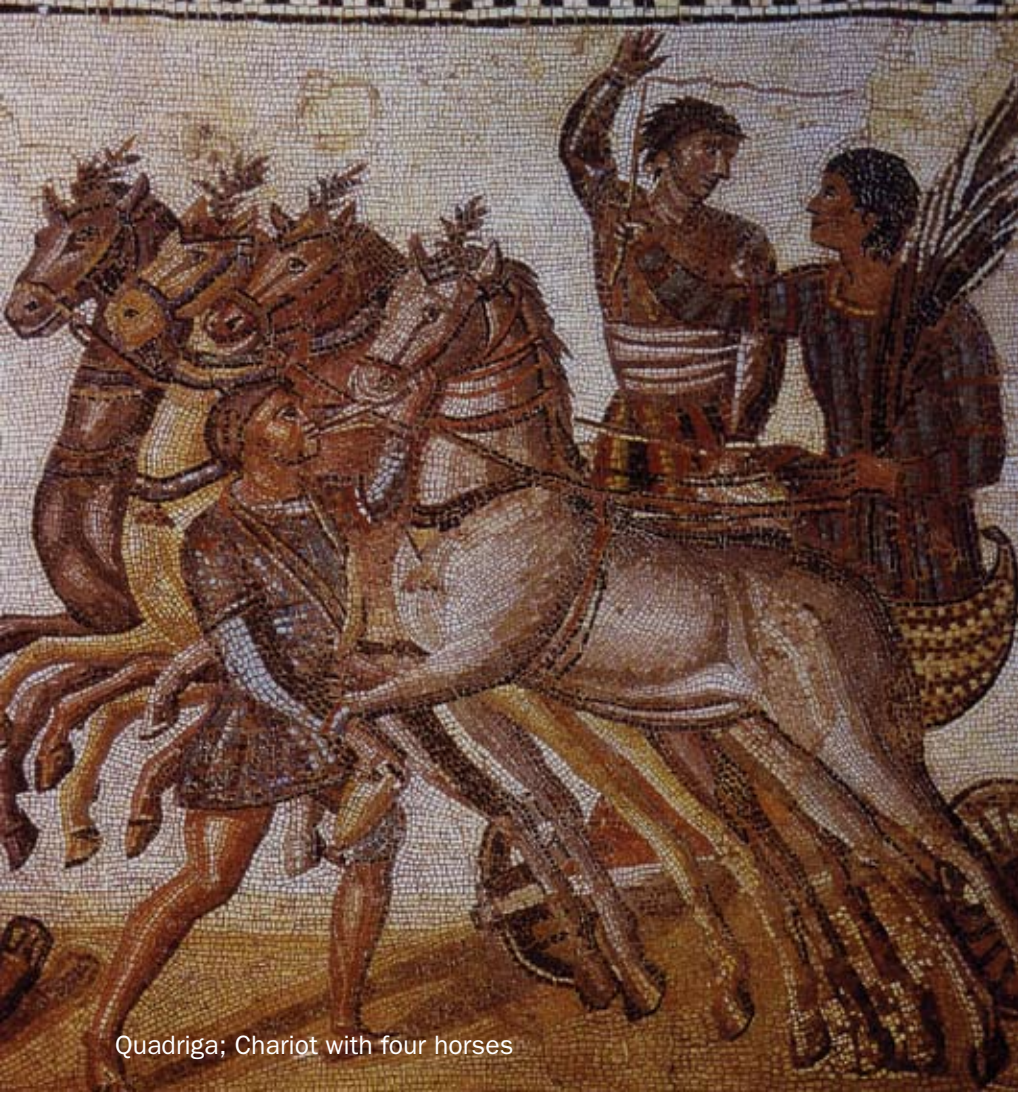
America's leading manufacturer of structural steel products now introduces a comprehensive guide to revolutionary sheet piling solutions.

This new reference tool features data on the latest generation of sheet piling - **PZC** - as well as innovative solutions for a world of piling situations.

To get your hands on a copy of the Chaparral Sheet Piling Handbook, go to **www.sheet-piling.com**

CHAPARRAL

800-527-7979



Quadriga; Chariot with four horses

tions were excellent and the province was surely heavily populated.

The Dimensions of the Circus

After several campaigns, from 1910 until 1988, the archeologists were able to determine the dimensions of the circus.

The total length was about 1,500 feet. The inside width reached 340 feet. The parallel stands and the circle were 3,200 feet long. The tribune was 40 feet deep and had 10 rows of seats with a walkway along the first row, and a balustrade. On top, behind the last row, a gallery circled the tribune used by flying traders (vendors) selling snacks and cold drinks and offering spectators the opportunity to walk around the area.

Based on the required space for a seat, the experts recalculated the capacity of the circus at 20,000 seats.

The Problems of the Foundation at the Site

Investigation of the Soil Conditions

The search for the soil conditions of the site was extremely difficult. The archeologists did no investigations in this direction. Boring logs were not available. Only the conservator of the museum could supply some information about the foundation of the modern building.

Following his explanation, the underlaying alluvial sediments were of different high plasticity and different thickness. The expected settlements of the soft clay could not be controlled. The final foundation used piles installed 100 feet to the depth of firm layers.

With photos and slides showing the soil layers, it was finally possible to reconstruct a very typical profile.

First, a thin layer of young organic black soil was followed by sand, sand mixed with gravel, and fine sand with some silt and cobble stones – the typical sediments carried by a river from the Alps.

Below this granular material the soil changes to blue soft clay of high plasticity, again very typical for the alluvial time. Since the Rhone broke through the last chain of mountains, the river is pushing toward the sea, filling the delta with the sediments it carries and creating new land.

After about 100 feet, we reach the bedrock.

The problem for any shallow foundation is clear: the bearing capacity is limited due the unconsolidated soft clay.

The Search for the Most Suitable Foundation Work

In the middle of the second century, the Roman engineers looked back on almost 850 years of construction business. A number of Roman buildings still stand and are in use today: bridges under the load of heavy trucks, arenas where spectacles are still presented, or imperial buildings turned to churches.

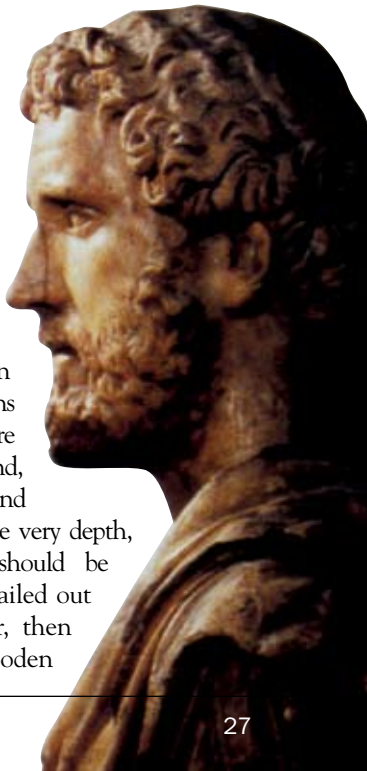
A solid foundation is required for any building and the structures are not always sitting on solid rock.

Caesar tells us the story of how he crossed the Rhine. His army corps of engineers were able to erect a bridge on driven piles within a few days. They used a sophisticated piling system to withstand the powerful stream. Piles were used to build cofferdams, foundations for bridges, dams and public buildings, and along waterfronts and in harbors.

In our case, the engineers did not hesitate to place the circus in the middle of a wetland, because they knew how to solve the foundation problem. They knew from the very beginning that piling work was the only solution for this project.

Possible Theoretical Model

We do not have many written documents about engineering in Roman times. Only Vitruvmentions foundation on piles. He explains as follows: "If there is no firm ground, but only loose and marshy soil to the very depth, then the site should be excavated and bailed out of all the water, then fire hardened wooden



Model of the foundation cells under construction

piles of alder, olive or oak should be installed, and hammered into the ground by a driving machine, very close together. The space between the piles should be filled with charcoal to provide a solid foundation wall to the structure."

The legions, with their army corps of engineers, were well-educated and used their codes. The knowledge of centuries and their experiences were exchanged and improved the engineering state of the art, permanently. Based on the mathematics and geometry of the Greeks, the Roman engineers did consider the interaction of forces and weight reduction.

For the foundation in Arles, they calculated the loads, determined the number of piles, and the length, diameter, and formation needed to transfer the weight of the structure safely into the soft blue clay. No responsible engineer cuts 30,000 trees, ships them to the site, makes all the driving, erects the building, and then waits to see if the circus stands or collapses.

Many historians believe that Roman engineers did not have the required mathematical science to develop any structural theory because no documentation exists to prove the interaction of analysis and design. Nevertheless, this argument is not consequential. It is the nature of engineering to develop a theoretical model for the designed structure to check out the action of weight and forces before the construction begins. This was, and is at all times, the state of the art.

The construction of the circus in Arles was a very important project, executed in the name of the emperor. Responsible people did not experiment. No one took risks. The consequences, in the case of failure, could have been deadly. Decades ago, Hadrian ordered the killing of his most famous architect, because he criticized his emperor.

The System of the Piling Foundation

The circus has a geometrical ground plan. The stands were also divided into thirty-eight sections with a stairway in the middle. This arrangement created a network of about 266 equal piling groups with the same pattern. Until today, not one of these cells had been excavated completely, but we were able to reconstruct the arrangement of the piling.

Along the inside of the stands, we find two rows of piles. For the massive foundation platform of about 3 feet 8 inches in width, the backside – with the load of ten rows – has a dimension of 5 feet 3 inches for a minimum of three rows of piles.

The soil engineers knew the relation between load and settlement in soft clay. The number of piles per square unit should be determined according to the surcharge. As a result, the load per pile should be almost the same. The engineer had to arrange the piling pattern, avoiding differences in the settlement during the construction phases, and the final heavy load of the arena.

Determination of the Bearing Capacity

The soft blue clay may have a low shear strength of about 250 pounds per square foot.

An average sized pile of 8 feet in length and a 10-inch diameter at the head, has a medium bearing capacity of 2,500 pounds.

Because the overload weight of the stands with 10 tiers increases from the front to the back, the engineers in charge placed a smaller trench with about two rows of piles at the inside, and a broader trench with a minimum of three to four rows at the outside.

The piling arrangement with 140 timber piles per one unit or cell, allows us a first estimate of the bearing load per pile.

With the cross-section and the dimensions of one cell, we calculate the dead load of the massive stone structure, and the live load when all seats are occupied. The load diagram shows the distribution along the podium trench, the middle trench and along the facade of the hippodrome. With the total of 140 piles and their distribution according to their loads, all places are loaded equally with 1,250 pounds (+/- 10 percent) to avoid different settlements, through different consolidation of the soft clay.

Because of the importance of the circus, no responsible engineer would have taken any risk. It is, therefore, relatively certain that a load test was done to ensure the success of the construction.

Execution of the Foundation

The Search for the Piles

According to the excavation of the archeologists, the piles were made from local oak trees and pines. It was not an easy job, in those days, for the lumber industry to cut the 25,000 to 30,000 piles in one winter. It was a big order.

In Roman times, the timber industry was one of the major suppliers of construction material for all buildings – public or private – including housing, factories, and legions, as well as for shipbuilding. Firewood was the basic energy source for heating the public baths, and all other buildings. Potters, blacksmiths, brick-makers and professions that used heat for the production of goods and food, also relied on firewood.

Lebanon, Asia Minor, North-Africa, Italy and other provinces were famous for their big forests of cedars, oaks and pines. But the trees soon disappeared. The clear-cut of the Romans destroyed the woods.

Timber Pile Identification Marks

Even today, it is almost impossible to reforest these areas. After 250 years of Roman civilization, the province around Arles was depleted of major woods, and the required piles had to be cut far away along the Rhone. Long distances were never a problem for any Roman contractor.

The Selection of the Trees

Two types of oak were cut, as well as three different types of pine.

All the trees still grow in the region around the city, on both banks of the river, and in the mountains.

The piles show they were installed as green wood, in fresh conditions. Leftover bark, mostly on top of the piles, indicates the time between cutting and driving was short.

The selection of the trees followed certain criteria: a straight trunk of about 10 feet or more with a diameter of about 1 foot. The trees were cut, de-branched and trimmed to shape.

The Trimming of the Piles

While observing the conserved piles exhibited in the museum near the hippodrome, we recognize the careful trimming. The trunk was freed from the bark, and shaped with an ax to an octagon over the full length, and only the last foot was trimmed to a pyramidal section. Because of the soft clay, no hardening was required. The piles were not cut symmetrically to the middle axes, but more diagonally with the tip outside the center. With this asymmetric arrangement, the tip did not lie in the weak heart of the trunk, but in the zone of firm wood, and an early damaging of the pile tip was avoided. After 1,850 years, the excellent condition of the piles is proof of the idea's efficiency.

Traces of the axes and saw-blades are still visible. The piles also bear (identification) marks driven into the surface with iron patterns. Until now, only two of them had been discovered. All characters and numbers of both are readable. The stamps are, possibly, brand names of the supplier or quality control marks of the pile driver.

The Coordination of the Different Activities

We assume the woods where the trees were cut were located along the

waterways. Shipping the trunks, or even the finished piles, on a barge to the site would have been the most reasonable way. The shipping was obviously coordinated with the installation. The huge number of approximately 30,000 piles required a sophisticated plan to get the cutting, trimming, shipping and storage in line with the installation on the site. The construction time was possibly limited by the deadline for the first opening of the circus. The construction started parallel in several sections of the site. This explains why all trees were cut in one winter in the years A.D. 148 to 149, to ensure enough piles were available for the driving.

A recalculation will show more about the daily performance required to finish the driving within a reasonable time.

The sequence for the installation of one pile includes the following actions: moving the driving guide to the next pile, setting up of the unit in vertical position ready for driving, and placing and driving the pile to final depth.

Because of the 10-foot-long piles and the soft clay, driving could be called easy. Therefore, we should investigate the moving of the rig from pile position to pile position. A normal lightweight, but stable guide, was sufficient. Such equipment was easy to move. Bringing the workers in position for moving the rig to the next place could have taken about five minutes before the group was able to push the whole unit farther, and then align the frame and guide again vertically. The pick up of piles from the stock, the lay out, and the check and control of all other actions, were of secondary significance. The agility of the rig determined the daily number of driven piles.

Based on experiences in China and Thailand with similar climate, we estimate two to four piles per hour could be done. With 12 working hours per day, 1,000 working days were required to install all the foundation piles.

While observing the site situation, we recognize that four or five parallel running construction teams would make sense because of the typical site in line. Four teams working in parallel could do the driving within one year.

The Preparation of the Site

Archeological Excavation of the Foundation

The archeological investigation allowed the reconstruction of the foundation system and the way in which driving was prepared and executed.

The archeologists removed soil layer by layer inside the cell. Prints in the soil indicate a trench was excavated for the foundation and protected by a cofferdam. As the digging reached the soft blue clay and the groundwater level, archeologists discovered a vertical adjusted wooden plank of 1-foot in height, fixed in this position by three short piles. The plank bordered one side of the form for the first foundation layer of gravel covering the pile heads.

The piling was uncovered to the very tip. All were completely under water and embedded in the blue clay. This method was the best way to conserve the wooden piles and to protect them against rot and wood pests. They are still in excellent condition and can be admired at the museum near the site.

Remnants of the Circus' foundation

The Preparation of the Site for Driving

With the knowledge of the archeological excavation, we see that driving work is still done in the same way today. First, the organic soil was removed and an equal level plane created. After the marking of the foundation, the contractor excavated a trench 9 feet deep, about 1 foot into the clay, and 4 to 5 feet wide.

Parallel with the excavation, the contractor installed a retaining system using vertical wooden soldier piles in a short distance filled with horizontal wooden planks and fixed with struts from wall to wall. Such protection was required to keep the trench open for the driving and the setting of the piles, avoiding possible ground failure.

We assume the regular groundwater level was several feet higher. An extensive dewatering system under the stands and the racetrack leads to this conclusion. A dry trench was necessary. The drainage was possibly done with man-powered double-acting pumps with two cylinders.

The Driving

The Driving Equipment

As previously explained, the driving conditions were easy. Driving below ground level, however, required a modified machine with a special rig and a longer frame to guide the hammer down to the bottom of the trench.

The Driving Rig

The high performance required a mobile unit that was easy to move. Because the trenches were of different widths, with two to four rows of piles, the pile driver had to switch from one side of the trench to the other. Or, the rig was placed directly over the trench sitting on a wooden platform, driving all the piles from this podium.

The rig was, in all likelihood, constructed of heavy wooden beams connected by iron bolts, and equipped with a counterweight to balance the hammer. The frame in front of the rig had leads to control the hammer, and to hold the pile under the hammer. The rig was mounted on a movable base, which was also the platform for lifting facilities. Lifting the hammer 4 to 5 feet could be done by several workers using a simple rope. A mechanical releaser would drop the heavy weight; the workers would catch the rope and repeat the procedure. With hoisting equipment, a heavier hammer could be used. Higher lifting with more drop height, combined with an automatic release for the hammer, improved the penetration per blow. In our particular case, lifting the hammer by workers seems the more appropriate way.

Preserved Timber Piles

The Hammer

We do not have any monument of Roman origin showing a pile driver at work, or any single piece of driving equipment. Pictures from the Middle Ages give us some impression of the rig and hammer in action. For more than 1,000 years, driving has not been much different from these pictures. The hammer was made out of stone – perhaps granite – with iron bands on top, in the middle, and at the driving level. A block that is 1 foot by 6 inches in diameter and 2 feet high is heavy, weighing more than 500 pounds. A smaller hammer, 1 foot by 1.5 feet, still weighs more than 175 pounds. This could have been the hammer size the pile driver used in our case.

The well-preserved conditions of the timber piles confirm the easy driving conditions. But the under floor driving might have required more sophisticated machinery using a driving cap. The cap held the

JUNTTAN

We design and manufacture the most advanced piling equipment for the world's leading piling contractors.

Junttan Oy

P.O. Box 1702
70701 Kuopio, Finland
Tel: +358 17 287 44 00
Fax: +358 17 287 4411
www.junttan.com
Email: junttan@junttan.com

Junttan Oy / USA Sales
Ahti Knopp /
Sales manager USA

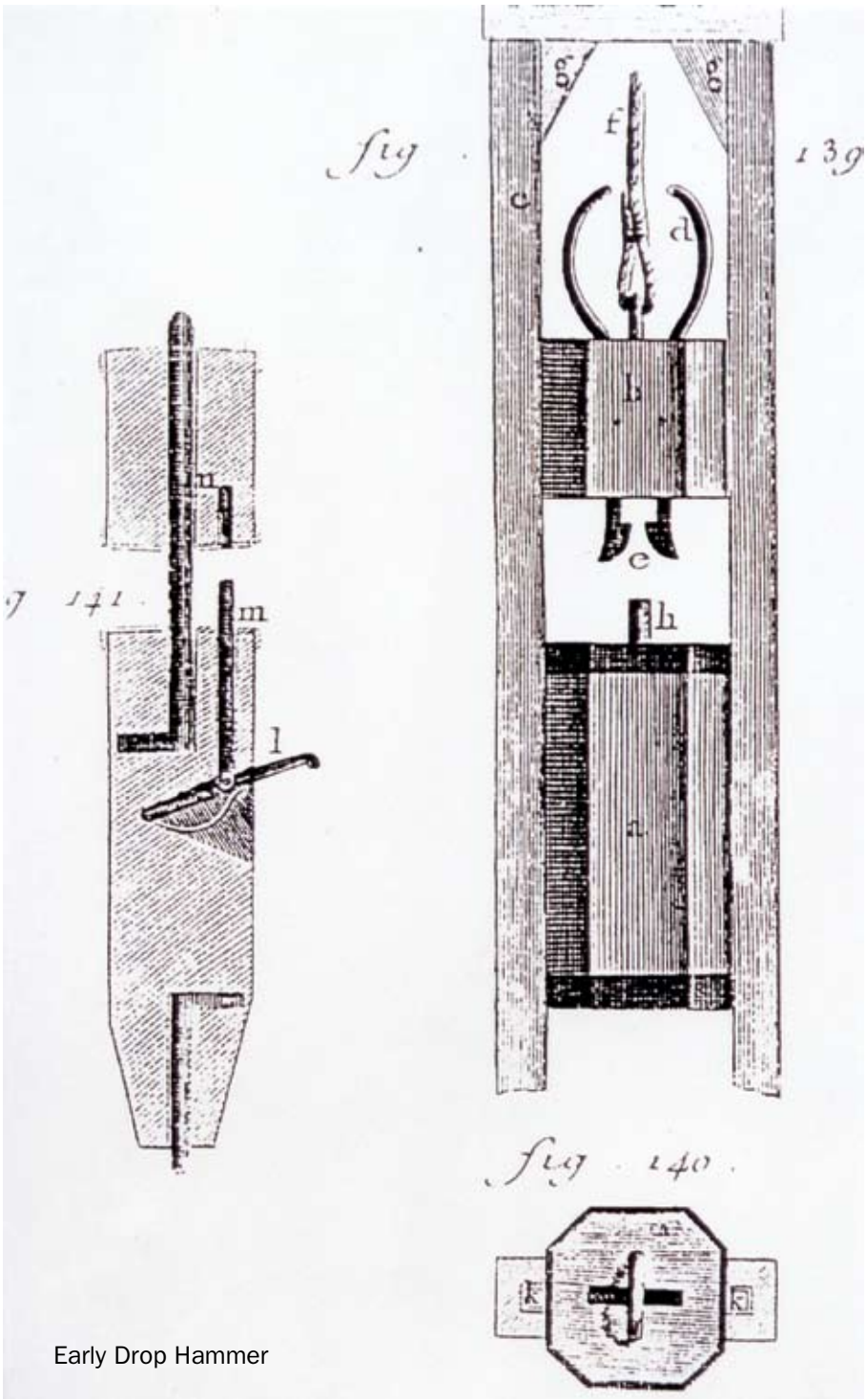
Tel: 1-404-514-8056
Email: ahti.knopp@junttan.com

S.P.E / Southeast USA
Zack Jahnigen

RD 4, Box 217B
Frankford, DE 19945
Telephone: 1-302-539-7187
Fax: 1-302-539-4443
www.spe-usa.net
Email: info@spe-usa.net

F.S. Supply / Northeast USA
Joe Savarese

P.O. Box 452, Keyport
New Jersey 07735
Tel: 1-732-530-3782
Fax: 1-732-530-5355
www.fssupplyco.com
Email: j.f.savarese@att.net



Early Drop Hammer

pile head in the center. The drop forces were concentrated to the vertical axis of the pile avoiding damage by dumpling.

That hammer could be handled by about four to five workers. The same crew could also move and adjust the rig together with the men laying out and setting up the piles.

The Design of the Foundation

The foundation system consists of the supporting piling work. The piling head was a platform for the massive stone wall bearing the stands with the tiers. The network of piles was cut with saws just above the bottom of the trenches. Next, the workers set wooden planks along the trench walls, building the form of the first layer of gravel and crushed stones, which covered the pile heads. Above this bed, the massive foundation was set up out of rubble stones in three steps of 3 feet each, to the top of the trench. The last foot was precisely placed. The top of the foundation wall was smoothed with a thin bed of cement for the big, square stones that formed the walls and arches of the hippodrome.

Conclusion

As a response to the challenge of difficult soil conditions, sophisticated foundations have been common among civil engineers since the very beginning of any construction business. This almost unknown project, the Circus of the Roman City of Arles, started in the year A.D. 900, and is a fine example of foundation engineering dating back 1,850 years ago. The history of the ancient engineers is still in the mist of the past. Modern archaeology could, however, unearth these mysteries in the years to come.

The design of the foundation was based on generations of engineering experiences. The soil engineers in charge knew exactly what foundation system was the best and most economical for the local soil conditions. The firm bearing ground was too deep below the surface. The engineers created a swimming pattern of timber piles to support the load of the heavy stands in the plastic, and very soft alluvial blue clay.

To keep the building in balance, every single pile was charged with the same load, ensuring that the consolidation of the ground under surcharge was the same in every place of the 1,476-foot-long station. The interaction between the bearing capacity of the soil and the actual load was known. The logical next step meant the load capacity of the soil had to be determined by driven piles and loading tests, the same way we do it today. The Roman engineer knew more about the interaction of the driving, the hammer weight, and the drop height and penetration per blow, than we are able to imagine.

This sophisticated foundation system of the Circus of Arles, based on driven timber piles, was carefully engineered and constructed in accordance to the given soil conditions of the site: a masterpiece of the Roman engineers of the second century.

A driven pile is a tested pile. ▼

CDS

Manufacturing, Inc.

For all your **Prestress Concrete Pilings**:

CDS Manufacturing, Inc.
441 South Virginia Street
Quincy, Florida 32351

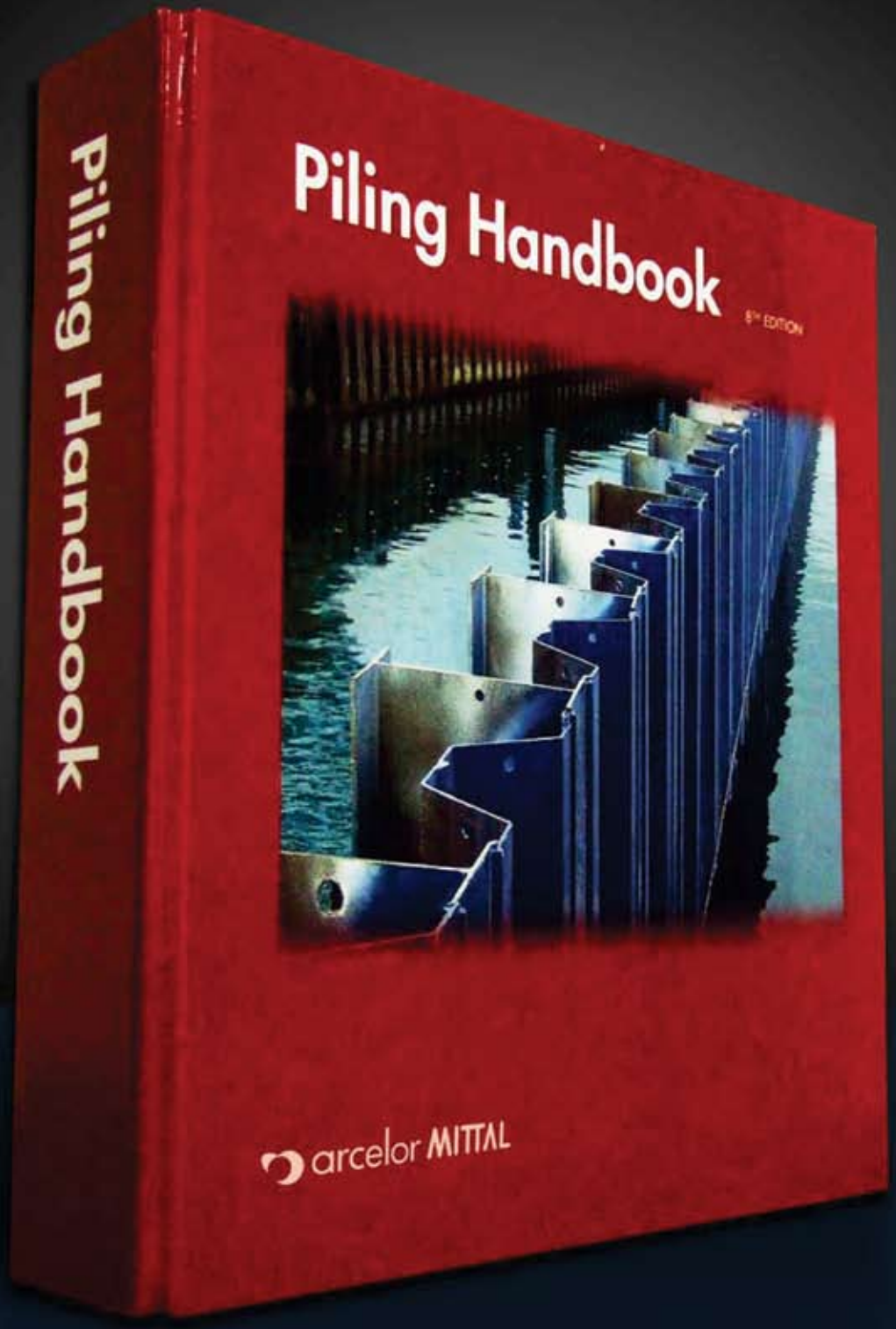
phone: 850 875-4651
toll free: 888 847-3188
fax: 850 875-4660

Providing quality **Prestress** & **Precast** products throughout the Southeast

visit us online at www.**cdsmanufacturing**.net

SHEET PILING? IT'S IN THE BOOK.

Over 300 pages of design and construction expertise from the most trusted source.



skylinesteel

To obtain a free copy of the ultimate piling resource, visit us at www.skylinesteel.com