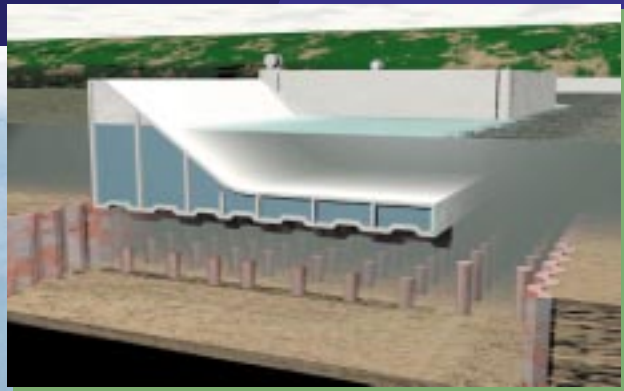
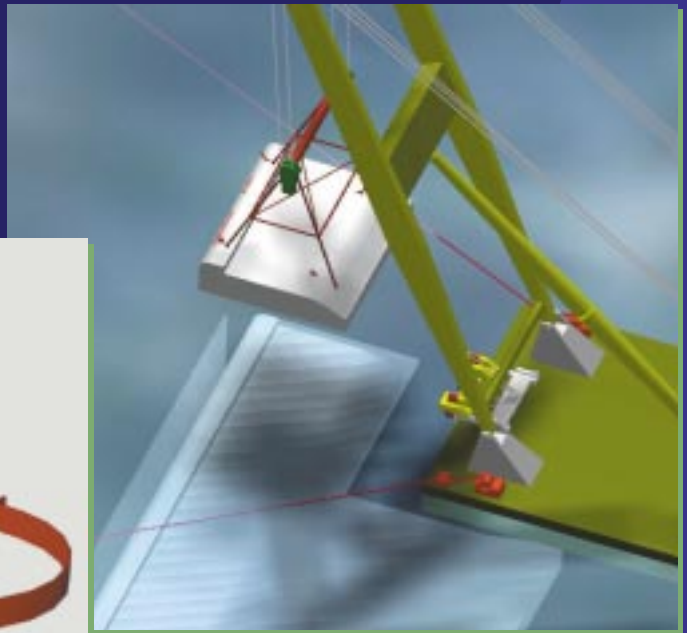




**Ben C. Gerwick, Inc.**

# NEWS





# Ben C. Gerwick, Inc. NEWS

## Published by

Ben C. Gerwick, Inc. 601 Montgomery St., Suite 400  
http://www.gerwick.com/ San Francisco, CA 94111  
Tel: (415) 398 8972  
Fax: (415) 433 8189

for its employees, affiliates and friends.  
Please contact the President for permission to reprint articles.  
© 1999 Ben C. Gerwick, Inc. All rights reserved.

## Editorial Board

Ben C. Gerwick  
Paul E. Bach

## Editorial Staff

Sam Yao	Thomas Dahlgren
Paul E. Bach	Ben C. Gerwick
John M. Vincent	Dale E. Berner
George C. Fotinos	Robert B. Bittner
Matthew Dry	Yu-Yi Hsu
Patrick E. Durnal	

## Cover Pictures

Richmond-San Rafael Bridge project  
and innovative construction techniques.

## Contents

### Movable Barrier Floodwall System — Flood Control On-Demand

*By Tore Abrahamsen*

### Design-Build Projects — Gaining the Competitive Edge Through Innovation

*By Robert B. Bittner*

### Richmond-San Rafael Bridge — Innovative Underwater Micropiles

*By Patrick E. Durnal and John M. Vincent*

### Marine Transportation Projects — Innovative “In-the-Wet” Construction Techniques

*By Paul E. Bach*

## New Publications and Presentations

ING-IABSE Colloquium on  
Foundations for Major Bridges:  
Design and Construction,  
Delhi, India,  
February 22-24, 1999;  
*Large Diameter Steel Tubular Piles  
for Optimum Seismic Performance,*  
by Ben C. Gerwick and Robert  
B. Bittner

IABSE Congress Lucerne 2000;  
*Marine Transportation Projects  
Use Innovative “In-the-Wet”  
Construction Techniques,*  
by Paul E. Bach

IABSE Congress Lucerne 2000;  
*Innovative Overwater Trestle  
Replacement,*  
by John M. Vincent and  
John A. Corven

Bridge Design & Engineering,  
February 1999;  
*Technology Transfer from the  
Offshore Industry to Design and  
Construction of Bridge Foundations,*  
by Robert B. Bittner

Concrete International,  
March 1999;  
*Effective Assessment of Repairs,*  
by Sam Yao, Mette Geiker, and  
Michael Faber

PCDC Association (Pile Driving  
Contractors Association) Winter  
Round Table at San Diego, CA  
Feb 19, 1999;  
Keynote Address: *Use of Large  
Diameter Piles for the Retrofit of  
California Toll Bridges,*  
by George C. Fotinos

# Movable Barrier Floodwall System

## Flood Control On-Demand

**B**en C. Gerwick, Inc. has recently worked with the inventor, Rick Adler, principal of RSA Environmental to develop a concept for a movable barrier floodwall system, MBFS. The concept was initially intended for use along flood-prone rivers where view and/or access to the water was essential.

The MBFS is a floating retaining wall that is harbored in a continuous concrete trough.

When the river flows at normal levels, the trough is empty of water and the MBFS sits on the bottom like a boat at low tide.

Before the flooding is about to begin, the trough is filled with water from a pumping station or domestic supply and the MBFS rises to form a continuous barrier against the rising river. To further increase the reliability, there are passive inlets that will fill the trough by the floodwater itself once the river reaches flood stage.

The MBFS is constructed out of fiberglass, which makes the floating wall very buoyant, strong and corrosion resistant.

Filling the core of the wall with closed cell foam ensures that buoyancy is retained in the event of accidental puncturing. The initial

concept focused on a wall that offered ten feet of flood protection, a five to six foot draft and an eighteen-inch beam. A force of approximately one thousand pounds per foot of wall length is initially required to keep the wall from rising from the trough, in other words, it is virtually impossible to accidentally hold the wall down in the event of a flood.

In the fully extended position the buoyancy force will depend on the amount of leakage between the individual units and between

the fiberglass wall and the neoprene gasket provided on the landside at the top of the trough. Various types of gasketing between units

were studied and the leakage is believed to be negligible; therefore, uplift restrainers are used to keep the wall from floating out of the trough.

Besides the aesthetic factors, the MBFS has some inherent advantages:

- Settlement is reduced since the installation weighs approximately



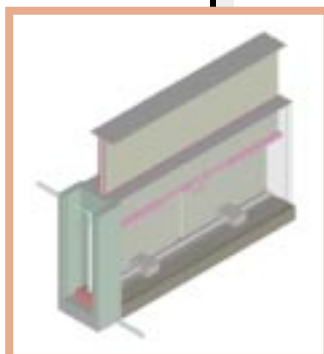
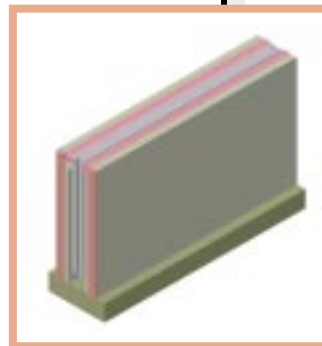
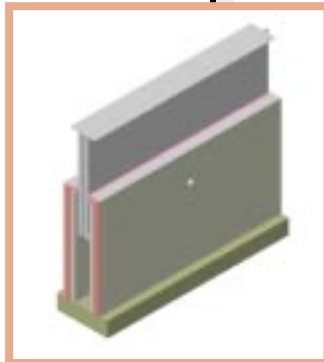
*MBFS model with walls extended*

the same as the soil being removed.

- The concrete trough prevents piping in the upper region of the levee.
- Highway embankments with underpasses can be incorporated into levees at minimal cost, since the MBFS are recessed and traffic can cross the barrier until just before the flooding.

The MBFS was initially intended for protection against flooding. Lately the concept has been proposed for both fish ladders and protection against terrorism. One could say that the MBFS and our involvement in the project are very much like the river, always flowing in new and interesting directions and you never know what is around the bend.

Tore Abrahamsen



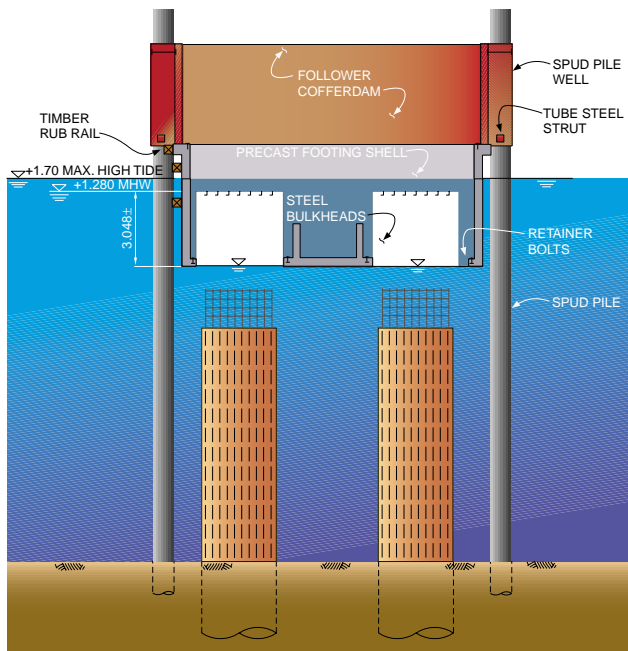
# Design-Build Projects

## Gaining the Competitive Edge Through Innovation

The use of design-build contracts for bridge construction is on the increase in the United States. This type of contract significantly changes the rules for obtaining and executing bridge contracts. This type of contract offers strong incentives for designers and contractors to jointly improve the constructibility and cost efficiency of their designs through the use of innovative construction techniques.

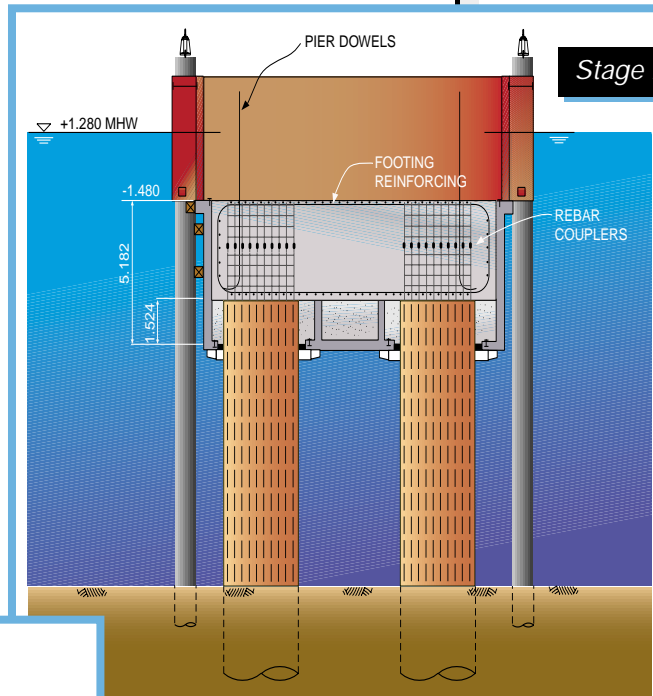
Under the old rules, the design and construction contracts

Stage 1 — float-in cofferdam



were awarded separately. The design was awarded primarily on the basis of the designer's reputation and the aesthetics of the proposed bridge design, and the construction contract was awarded on the basis of the lowest competitive bid.

Under design-build, the owner will typically establish what he wants with a "definition-design"



Stage 2 — float-in cofferdam

deciding factor. The significant change for design firms is that they will now be more directly accountable for the finished cost of the bridge. Their preliminary designs will now be submitted to the owner with a fixed price attached. Their

which takes the design to 20% to 30% level. This design is then put out for tender as a design-build contract with the basis of award being typically a combination of the qualifications of the design/build team members, the aesthetics of the design, quality, maintenance requirements and the proposed fixed price.

Qualifications and aesthetics are usually

designs must be cost-efficient to build or they won't even be in the running. For the contractor, the big change is that he will be able to take advantage of his experience and imagination to influence the design of

Completion of pier shaft and stripping of follower cofferdam



the deciding factors only when the cost difference between competing proposals is small. However, as the cost difference between proposals increases and as budgets are exceeded, cost becomes the

bridges and significantly affect the cost of bridge construction. The award of bridge construction contracts will no longer be based solely on who can build a given design to the lowest

cost, but will now be based on how successfully the contractor and designer can work together to develop a cost efficient bridge design that is easy to build.

The area with the greatest potential for cost improvement is in the design and construction of bridge foundations; the piles, footings and piers. Over the last 100 years, advances in bridge superstructure design and construction have outpaced advances in foundation design and construction. Bridge substructures built today still rep-

resent 40% to 50% of the total cost of over water bridges. This area of bridge design and construction offers significant opportunity for cost reduction through the use of innovative construction techniques. Innovations in bridge design and construction can offer lower cost, shorter construction schedules, higher quality and even lower risk. However, innovation

is often discouraged by owners, designers and contractors because of the perceived risks associated with the unknown and the unproven. One way of gaining the benefits of innovation without the added risks is through the transfer of proven technology from one field to another. The offshore oil and gas industry is a rich source of proven advanced technologies that are highly applicable to the design and construction of bridge foundations.

1. Minimizing in-water work wherever possible through the use of on-shore prefabrication and assembly. On-shore work is not only more efficient and safer, but labor rates and workers' compensation rates are often lower.
2. Standardizing the foundation elements as much as possible to allow repetitive production and high reuse of form systems and other specialty equipment.
3. Designing for concurrent construction by allowing the foundation piles to be installed while the precast pier elements are being prefabricated on-shore.
4. Identifying the advantages and strengths of

Alex Fraser Bridge



Fast, simple and economical construction of the deck for the Alex Fraser Bridge

the contractor and making use of them where possible. For example, be aware of the size of the contractor's existing drilling and pile driving equipment, the capacity of available cranes, and the size and capacity of existing casting yards.

Ben C. Gerwick, Inc. provides these innovative foundation design services as a stand-alone package, or as part of a complete bridge design package in cooperation with our sister company, Buckland & Taylor Ltd. Buckland & Taylor is a specialist bridge engineering company based in Vancouver, British Columbia. The firm has designed numerous long span bridges world wide including the Alex Fraser Bridge, the longest span cable-stayed bridge in the Americas.

Robert B. Bittner

resent 40% to 50% of the total cost of over water bridges. This area of bridge design and construction offers significant opportunity for cost reduction through the use of innovative construction techniques. Innovations in bridge design and construction can offer lower cost, shorter construction schedules, higher quality and even lower risk. However, innovation

Ben C. Gerwick, Inc. has a long history of successful performance in the design and construction of offshore structures. This experience is now being applied to the development of innovative solutions for the design and construction of bridge foundations. Our focus on innovation has been directed towards four specific areas:

# Richmond-San Rafael Bridge

## Innovative Underwater Micropiles

Previous NEWS articles on the Richmond-San Rafael Bridge have highlighted our innovative retrofit strategies using eccentric braced frames, precast concrete pier jackets, and large diameter tubular piling driven through precast pilecap elements joined underwater using tremie concrete. This issue features our use of high capacity micropiles installed through the existing belled-piers to supplement the lateral and overturning resistance of the existing foundations. Connection details and construction procedures were developed specifically to eliminate the need for enlarging the existing foundations or for constructing temporary cofferdams. Only a minimum amount of diver time will be required.

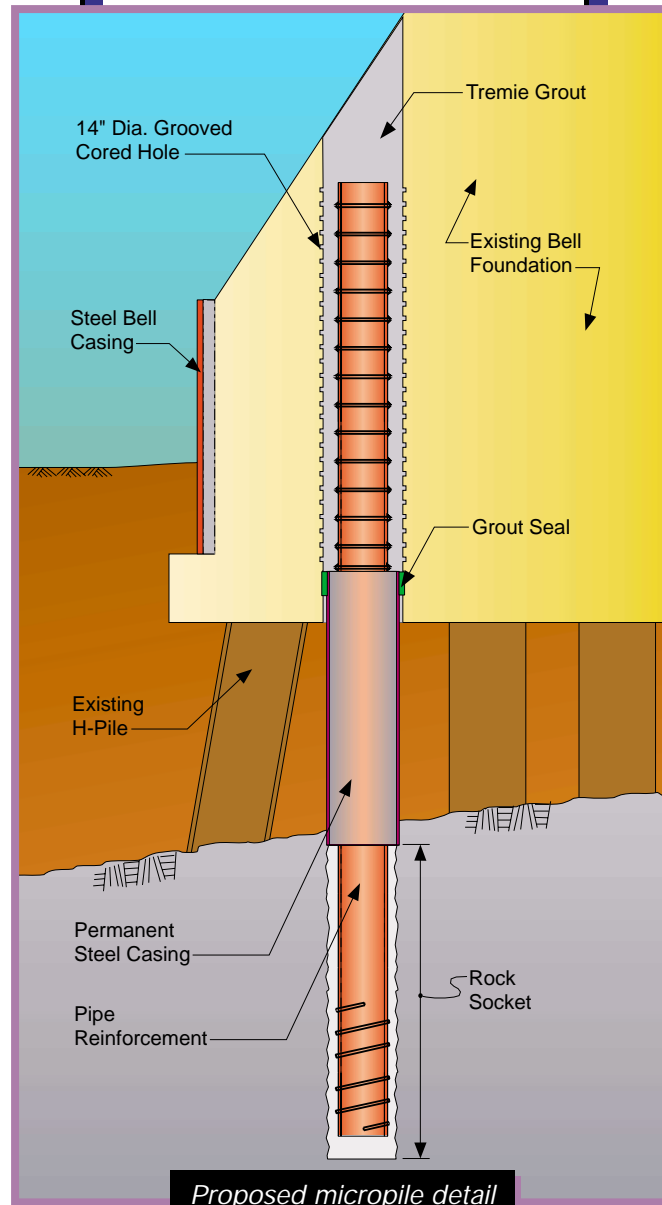
Micropiles will be installed at 31 of the 62 belled-pier foundations supporting the double-deck structure. At pier locations where the existing 14x89 H-piles run only a short distance to rock, the micropiles provide a reliable uplift and overturning resistance by preventing geotechnical pile pull-out failures. At other locations the micropiles augment the existing piling to limit axial forces and lateral displacements. The new micropiles will be proof tested in tension to test loads ranging from 290 to 1,140 kips.

Design loads for the micropiles were determined using the soil-

pile-interaction program GROUP, by ENSOFT™. Foundation demands were determined from global analyses using the finite element

magnitude 8+ earthquake on the San Andreas Fault, or a comparable magnitude 7.25 earthquake on the closer Hayward Fault. These earthquakes are capable of producing severe ground shaking lasting 20 to 40 seconds, or more.

Installing the micropiles will require coring 14-inch diameter holes through the foundation bells, advancing permanent steel casings through overburden soils to bedrock, drilling bedrock sockets, and installing and anchoring steel pipe reinforcement using grout. The cored holes will be grooved to improve the bond between the foundation bells and pipe reinforcement. The minimum specified bedrock penetration addresses individual and group pull-out failure mechanisms. The micropile pipe reinforcement consists of full-length, API-5L, Grade X52 pipe, 8<sup>5</sup>/<sub>8</sub> inches in diameter with 7/8 to 1 inch wall thicknesses. The top and bottom of the pipe reinforcement will have shear rings to enhance bond resistances at the foundation bells and rock sockets in accordance with API-RP2A requirements. Sufficient lead-time will be required for procuring the estimated 47,900 lineal feet of heavy-walled pipe. Bedrock bond length requirements and the total quantity of pipe will be determined through performance testing at the beginning of construction.



Proposed micropile detail

program SADSAP, developed by Professor Edward Wilson. Caltrans, Geomatrix Consultants and Earth Mechanics jointly developed the mudline time-history motions. The retrofit prevents collapse of the bridge during a

The micropile installation will be challenging because it is over water and must, in many cases, be carried out with limited overhead clearance. Special work platforms and templates will be needed to successfully core holes through the sloped, conical surface of the foundation bells 30 to 40 feet below water. Customized drilling equipment with reverse circulation capabilities, limited overhead articulations, and tool racks will be needed. Down-hole hammer drills, drill string centralizers, tri-cone roller bits, down-hole casing cutters, and over-reaming attachments may all be necessary for successful installation. It is envisioned that tools developed for the off-

shore petroleum industry will facilitate the pile installation and allow for an efficient blind-hole connection to the pipe reinforcement for the purpose of random proof load testing.

Polymer slurries were specified to prevent slaking and deterioration of the bedrock sockets when exposed to sea water. Thus, a slurry plant, along with the associated disposal and handling equipment, will be required. Even though a construction test boring program has been specified to provide supplemental site data, it has been anticipated that irregularities in the bedrock profile will necessitate pile length adjustments during construction. The specifications have been written to accommodate this eventuality.

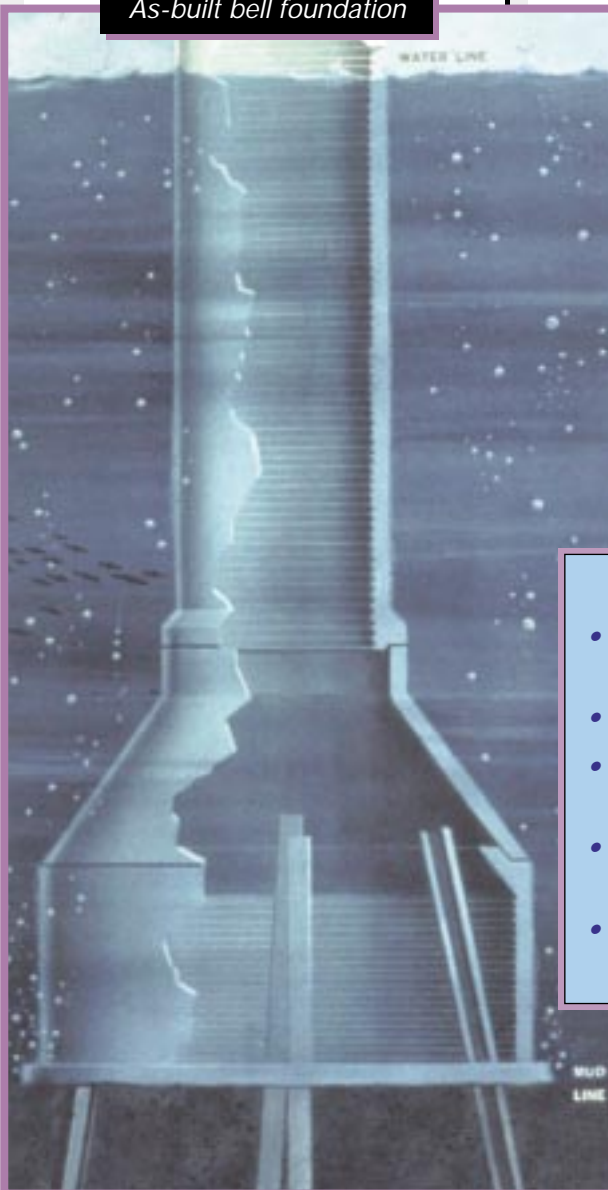
This project was completed with our partners, Sverdrup Civil and DMJM for the California Department of Transportation (Caltrans).

Patrick E. Durnal and John M. Vincent



Micropile construction:  
Calif. Hwy. 980/580 interchange retrofit

As-built bell foundation



### Advantages of Micropiles

- Small diameter fits within existing pile layout so that no foundation enlargement required
- No significant added mass
- Concrete-filled pipe provides excellent flexural ductility and buckling resistance
- Rock socket develops full tension yield capacity of pile, over 1,200 kips
- Small moment of inertial does not significantly alter foundation stiffness

# Marine Transportation Projects

## Innovative "In-the-Wet" Construction Techniques

"In-the-wet" assembly of precast concrete segments transported to the construction site has numerous advantages in the construction of navigation structures and bridge piers:

- Reduced disruption to navigation traffic, water flow and a lower cost of construction through the elimination of conventional large sheet-pile cofferdams.
- Reduced environmental impact by reducing dredging and elimination of site dewatering.
- Shorter construction time by allowing concurrent construction of precast segments and foundations.
- Higher quality by allowing the use of precast concrete produced in a controlled environment.

In partnership with the US Army Corps of Engineers

shells onto a prepared bottom with predriven piles for a new navigation dam on the Ohio River while



*Construction technique pioneered in the 1950s*

tion dam. These projects were designed with our partners, Sverdrup Civil and Bergmann and Associates for the Louisville and Pittsburgh districts of the USACE, respectively.

The 4.1-mile-long Richmond-San Rafael Bridge, spanning

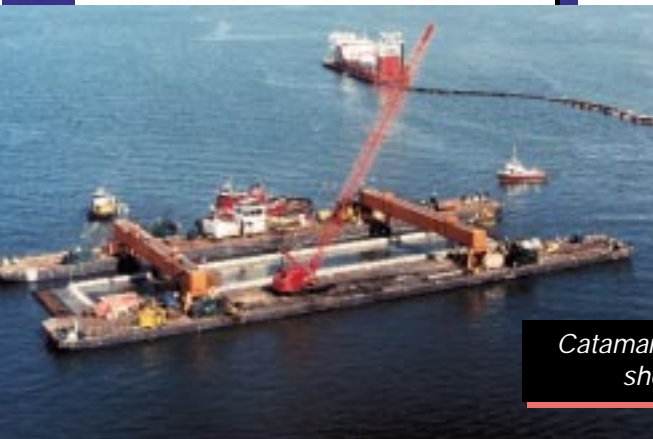


*Float-in precast concrete segment concept for tunnel construction*

keeping existing navigation traffic uninterrupted. Tremie concrete will be used to integrate the shells with the piles to form a continuous dam and stilling basin. Similarly, we have developed "In-the-Wet" construction techniques with off-site prefabrication combined with lift-in or float-in of large precast

across San Francisco Bay is currently being seismically upgraded. New precast pile caps, through which large diameter piling is driven, ensures that horizontal seismic forces are transferred between the new piling and the as-built foundation. Precast concrete jackets are designed to enhance the ductility of the existing concrete shafts. All new foundation work is designed to allow no interruption of traffic flows. This project was completed with our partners, Sverdrup Civil and DMJM for the California Department of Transportation (CalTrans).

Paul E. Bach



*Catamaran barge for precast shell deployment*

(USACE), we have examined the use of a catamaran barge to lift-in 4,000-ton precast concrete

concrete segments onto preinstalled foundations for Braddock Dam near Pittsburgh, replacing an existing naviga-