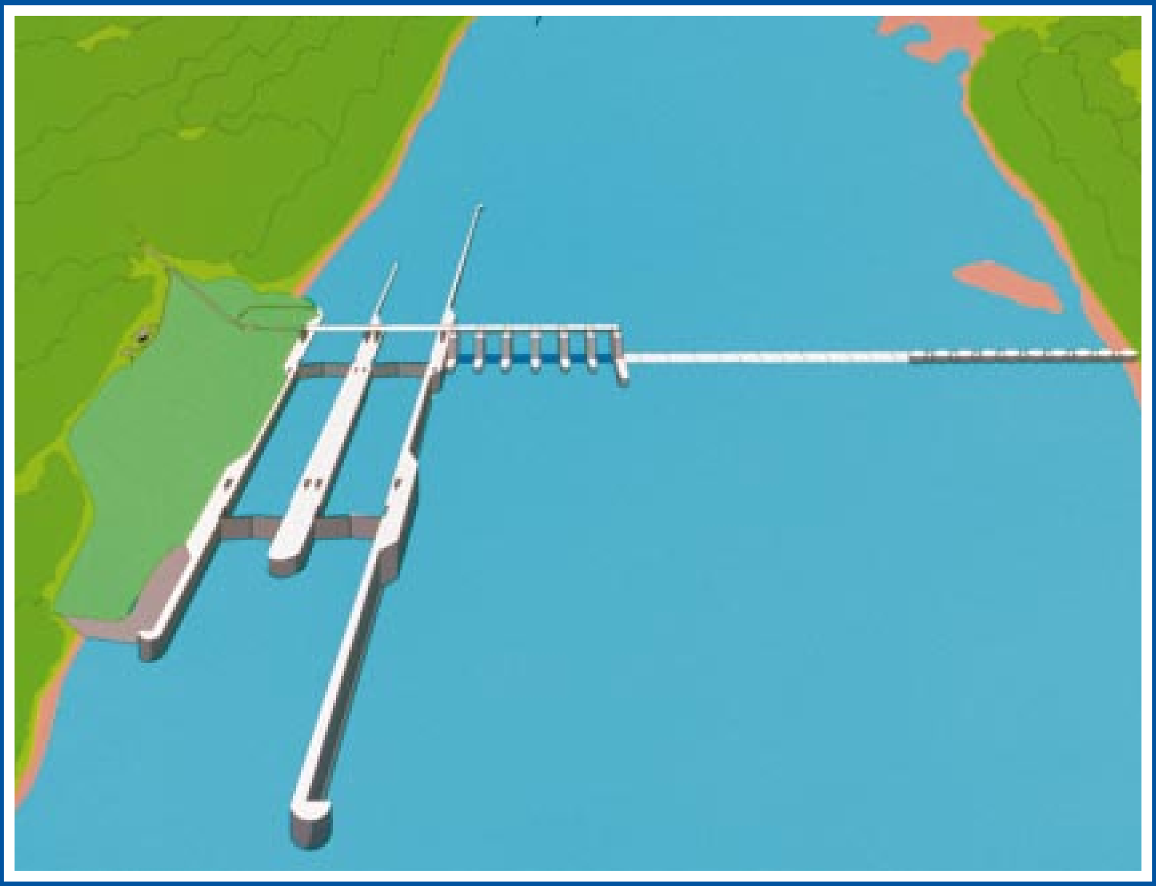

BEN C. GERWICK, INC.

NEWS

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NEWS

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Cover Picture
Olmsted Locks and Dam Project.

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Olmsted Dam on the Ohio River Initial Design

The Sverdrup/Gerwick Joint Venture has begun work on the first phase of the design contract for the Olmsted Dam, working for the United States Army Corps of Engineers, Louisville District. The Olmsted Dam is part of the Army Corps premier civil works project, the Olmsted Locks and Dam Project, which has an estimated construction cost in excess of $1 billion dollars. Ben C. Gerwick, Inc. will take the lead in the areas of innovative marine construction methods, marine foundation design and construction, tremie concrete construction techniques, and seismic design. Sverdrup Civil, Inc., a nationally, and internationally, renowned Engineering Consultant will focus on conventional construction methods and manage the overall project.

As part of the initial work, several construction alternatives will be provided to the Army Corps for consideration. Ben C. Gerwick, Inc. is developing proposals for "In-the-Dry," "In-the-Wet," and a combination of both. The "In-the-Dry" method requires constructing the dam using two or three stages of traditional, fixed cellular-sheet-pile cofferdam techniques. The "In-the-Wet" method may utilize a crane barge to place large precast shell elements onto pile foundations. Tremie concrete would be placed in the large void area between the shell elements and pile foundation. A heavy lift-in method, with precast elements weighing 2,000 tons, and a light lift-in method, with elements weighing approximately 600 tons, are being considered. If the "In-the-Wet" method is selected, the project would be a demonstration of innovative construction techniques that could be used on subsequent projects.

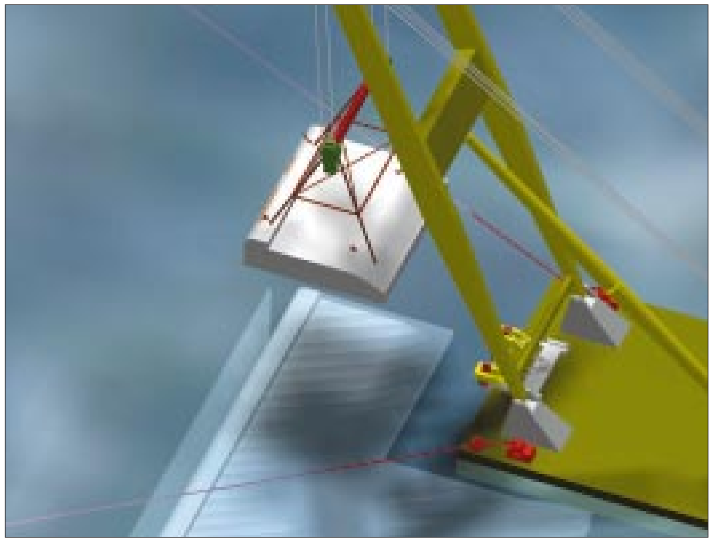

Illustration of precast concrete shell placed for Olmsted Dam.

View of heavy-lift crane moving precast element.

Ben C. Gerwick, Inc. originally developed the method as part of a feasibility study for the U.S. Army Corps of Engineers. The feasibility study concluded that the "In-the-Wet" method would offer significant advantages over the traditional fixed cofferdam method, including substantial cost savings, shorter construction duration, reduced environmental impact, and greater construction safety. The "In-the-Wet" construction of the tainter gate section, and of a similar wicket gate section of the dam, were previously addressed in the November 1994 and the March 1994 issues of BCG News, respectively.

Major engineering challenges associated with the project include:

- designing for over an 8.0 maximum credible earthquake in an area of potentially liquefiable alluvium,
- maintaining vessel traffic along the river,
- accommodating fluctuating river elevations between 30 to 40 feet annually,
- designing for the scour and uplift forces of artesian ground water,
- preserving a wild-life sanctuary on the Southern shore at the dam site

The first phase of the design contract will be completed with submittal of the preliminary design, which is scheduled for 1998. The final plans, specifications, and cost estimates will be completed in the second phase of the contract. The final construction is expected to be completed in 2008.

Dale E. Berner

Eccentrically Braced Towers Support Bridge Retrofit

Ben C. Gerwick, Inc., managing partner in a three-way Joint Venture with Sverdrup Civil and Daniel, Mann, Johnson & Mendenhall, is responsible for the seismic retrofit design of the foundations, concrete piers, and steel towers supporting the double-deck truss spans of the Richmond-San Rafael Bridge. When this bridge opened to traffic on August 31, 1956, it became California's longest steel bridge, stretching more than 21,000 feet across the northern end of San Francisco Bay. The retrofit design will rely on the installation of eccentrically braced steel frame towers at scales never before used. To the author's knowledge, this will be the first time eccentrically braced frame towers have been used for a bridge substructure.

Typical two-legged tower.

Eccentrically braced frames (EBF), with their favorable elastic stiffness and post-yield rotational characteristics, enabled the designers to minimize the drifts imposed by a 100 mph wind while providing a "fusing" element to limit the forces transmitted to the superstructure and foundations during a maximum credible earthquake. The towers range in height from 54 to over 135 feet. EBF will allow the existing concentric chevron bracing, which is susceptible to a catastrophic buckling failure, to be removed. The new EBF towers avoid the excessive weight a concrete retrofit solution would have imposed on the foundations and they have the advantage of being compatible with the bridge architecture. This last point was instrumental in gaining the approval of San Francisco's Bay Conservation and Development Commission.

The EBF will be installed in pairs. The bracing between each pair of frames will provide stability and prevent out-of-plane buckling of the yielding horizontal link beams. Special rod and clevis bracing will accommodate the shear deformations of the links. The typical 35-foot wide frames will have 12-foot long link beams to maximize their post-yield drift capabilities. The depth of the link beams are varied to ensure that they all reach maximum rotation at approximately the same time. Web and flange thicknesses are kept constant so that all link beams within a tower can be constructed from plate steel taken from the same heat, thus achieving a common yield stress. To further ensure that the links yield at approximately the same time, relatively stiff

Dual EBF tower retrofit.

frame legs are used to enforce uniform drifts and link beam rotations. The frames will be supported on common hinged bearing assemblies, allowing the towers to rotate out-of-plane and avoid imposing additional overturning moments in the weak direction of the foundations.

The tower retrofit requires that the existing cellular tower legs continue to carry gravity loads transmitted through the truss shoes at the top of each leg. The interaction between the existing legs and new frames was a significant feature of the retrofit design. The seismic drift demands imposed on the legs will be sufficient to cause yielding. The cells at the base of each leg will be filled with concrete to prevent local buckling from jeopardizing their load carrying ability. This concrete will be placed in layers separated by a compressible joint material to avoid stiffening the legs and causing yielding to occur above the concrete in-fill. New cover plates above the plastic hinge zone will ensure that yielding at mid-height transition sections and splices does not occur.

John M. Vincent

Great Belt Fixed Link Substructures Completed

The fixed link across the Great Belt is comprised of three major contracts:

East Bridge: A 6.8 km road bridge connecting Zealand and Sprogo.

West Bridge: A 6.6 km combined road and rail bridge connecting Funen and Sprogo.

East Tunnel: An 8 km bored rail tunnel connecting Zealand and Sprogo.

Ben C. Gerwick, Inc.'s parent company, COWI of Denmark, has been the lead consultant for all three construction projects. Ben C. Gerwick, Inc. assisted COWI on ship collision studies, concrete durability recommendations and concrete caisson foundation design, construction and deployment.

The overall concept for all substructure work has been based on onshore prefabrication of large, high quality concrete segments in a controlled environment. The onshore precasting was executed in a number of ways ranging from dry dock and quayside to skidway construction.

Upon completion, the precast concrete units were deployed by floating or crane barge techniques. Floating concepts were used for the very large caissons of the East Bridge anchor blocks and pylon foundations. These caissons had a weight of up to 50,000 metric tonnes. All units for the entire West Bridge and the substructure for the East Bridge approach spans were deployed by self-propelled crane barges with a capacity up to 7,500 metric tonnes.

Offshore joining of precast segments below sea level was carried out with wet pours in the dry - behind removable/reusable steel cofferdams. All caissons were placed directly on clay till in the Great Belt on a prepared bed of compacted and screeded gravel, in some cases followed by under base grouting for better contact.

Construction tolerances were generally achieved within one inch - even for the largest 50,000 tonne precast concrete units. Speed of erection, vital for this large construction project was of the order of one unit/day for the up to 7,500 tonne "smaller" units, deployed by the self-propelled crane barges, while the large, 50,000 tonne float-in concrete caissons were deployed within 48 hours over a distance of up to 35 km.

Paul E. Bach

Precasting of West Bridge units on skidways.

Drydocks for caisson construction up to 50,000t.

Deployment of precast superstructure unit by crane barge.

Deployment by floating technique of anchorblock caisson.

Pier Protection of the New Sidney Lanier Bridge

Previous ship collisions with the Sidney Lanier Bridge and increasing vessel traffic on the Brunswick River in Georgia have prompted the replacement of the lift span bridge with a cable stayed structure. The existing lift span bridge, shown below, has a 250 ft lift span. The cable stayed bridge will have a 1250 ft main span and provides a 185 ft vertical clearance at mean high water on the 400 ft wide navigational channel.

Ben C. Gerwick Inc. was retained by DRC Consultants, Inc. for the development of the design requirements and the design of a pier protection system for the main piers of the New Sidney Lanier Bridge. Ben C. Gerwick, Inc. utilized the expertise and specialized computer modeling programs of COWI, Ben C. Gerwick's parent company, and the Danish Hydraulic Institute.

The analyzes included parallel risk assessments for unprotected piers and piers with protective islands for the relevant design scenarios and design requirements.

The *ShipRisk* program, developed by COWI, was used for the risk analysis of ship collisions into the piers and the protective islands due to navigation errors and technical failures. The *ShipRisk* collision models are based on numerous parameters, including:

- bridge geometry and strengths,
- available water depth,
- ship traffic,
- navigational routes used when approaching the bridge,
- navigation characteristics, and
- several collision accident scenarios.

Collision frequencies were calculated for each vessel size. Each vessel size was associated with a collision force, and by comparison of the collision forces with the assumed collision capacity of the main piers, the potential unprotected collapse scenarios were identified. An energy and run-up relationship was used to evaluate and select a design ship for the protected piers.

The design requirements for the main piers and the protective islands were determined by successive adjustment of the collision capacity for the piers and subsequent reassessment of the total collapse probability. The minimum collision capacity that lead to a collapse frequency which fulfills the risk acceptance criteria was used to define the design requirements.

The pier protection islands were sized with the assistance of the Danish Hydraulic Institute (DHI). The design requirements were based model testing of the pier protection for the Sunshine Skyway Bridge in Florida and the Great Belt in Denmark and modeling results of the *ShipCol* program developed for these projects. DHI used the *ShipCol* program to determine collision consequences and associated impact forces based on the speed, course, size, bow shape, and hull stiffness of the design vessel and the material properties and geometric shape of the protective island. It concluded that the design vessels would be stopped before they reached the pier structure. The lateral forces transmitted to the main piers from the collision governed the drilled shaft foundation design.

Ben C. Gerwick, Inc. prepared the details of the protective islands for the final construction drawings. The final design maintains a 60 feet clearance from the rectangular pier footings to the top of slope. The island's sides slope, protected with armor stone, slope at 2:1 to the river bottom.

The Islands will be constructed in 1997 after the main pier cofferdams and foundations are completed. Approximately 75% of each island will be constructed under the main pier and span contract. The remaining portion will be completed after demolition of the existing bridge which is within the limits of the protective islands. The islands will cost up to 30% of the $65M main span contract.

Patrick E. Durnal

Existing Sidney Lanier Bridge

Progress Update on Hong Kong Airport Access Bridges and Jamuna River Bridge

The Tsing Ma Suspension Bridge and the Kap Shui Mun Cable-Stayed Bridge in Hong Kong are now substantially complete. All deck girders have been erected and installation of the railroad track supports (track form) are being completed, as is cable wrapping and deck surfacing.

This is a truly remarkable accomplishment, with two of the world's largest and heaviest bridges of their respective types nearing completion on-schedule.

The Ma Wan Viaduct main structure, a heavy double-decked prestressed concrete structure, elevated high above Ma Wan Island, is now structurally complete.

A third bridge, the Ting Kau Bridge, leading from Tsing Yi Island towards China proper, although started much later than the others, is well underway. It will be a double cable-stayed bridge: that is, two cable-stayed spans back to back, with single pylons and 4 lines of stay cables.

At present, the main pylons are being constructed as well as the complex interchange viaducts at the bridge ends.

When all bridges are completed, rapid transportation, both road and rail, will speed passengers from the new Chep Lak Kok Airport to Hong Kong and to South China.

Tsing Ma Bridge nearing completion.

Kap Shui Mun Bridge in final stages of construction.

Both the Jamuna River Bridge Contract and the River Training Contract in Bangladesh reached 50% completion on schedule. The last of the 121 giant piles, 3.15 m and 2.5 m in diameter, and 80 m in length was successfully driven to grade. A previous issue of BCG News carried the erroneous statement that these piles were driven at rates up to "5 per day" - this should have been "5 per week."

The West Guide Bund, an embankment 2500 m in length with riprap protection against erosion, is now substantially complete. The use of a temporary sand embankment, with rock groins, enabled work to be carried out even during the early stages of the monsoon flood. In October, when the river level again drops, the construction of the East Guide Bund will start.

For the Jamuna River bridge superstructure, the 600 ton launching gantry has now been erected and tested. Manufacture of the precast concrete segments has commenced, but unfortunately is behind schedule. Erection of the first 100 m span commenced in September and is expected to proceed at the rate of 1 span every 10 days, once the learning curve has been mastered.

The writer is retained as a member of the Technical Advisory Boards for these Projects.

Ben C. Gerwick, Jr.

Fender System for Duwamish River Bridge


Precast concrete fender walls with temporary braces to concrete deck.

Ben C. Gerwick, Inc. was selected by the Atkinson Construction Company to design an alternative fender system for the Duwamish River Bridge in Seattle. The alternative design was approved by the Washington Department of Transportation as a cost reduction incentive proposal. The fender system is under construction and is scheduled to be completed in November, 1996. The savings with this alternative design is approximately $1 million.

The project involved designing two 450 ft long fender systems to protect four bridge piers from damage by accidental collision of barge traffic in this two-way navigation channel. The width of the navigation channel between bridge piers is 145 feet and the commercial ship traffic in the area varies from medium barges to large barges.

The concept developed by Ben C. Gerwick, Inc. was to design the fendering for an average usage situation; that is, collisions of either a medium or large barge with the parallel guidewall section of the fender. In this case, the fender is able to effectively absorb the entire collision energy without damage to the barge and piers.

To effectively absorb collision energy while protecting bridge piers and their underwater connecting struts from damage, the fender system is divided into two sections, the guide-in section and parallel guidewall section. Each section is designed by balancing the elastic and plastic responses of the supporting piles with the soil under the maximum collision energies and forces to meet the design criteria.

The developed fender system uses precast concrete fender walls connected to precast horizontal decks by Dywidag bars. The concrete walls and decks bear against the top of the supporting piles with elastomeric bearing pads. This fender system offers greater advantage in ease of construction and allows collision energy and impact forces to be distributed over many more supports when compared to the fender wall rigidly connected to the supporting piles. With the consideration of the flexibility of supporting caissons and the movement and rotation of the fender walls over the supporting piles in the event of vessel impact, sizes of the supporting piles can be determined at each section along the fendering.

George C Fotinos and Yu-Yi Hsu

New Publications and Presentations

Durable Concrete for Northern Environments.
Ben C. Gerwick, Jr.

Rapid Repair Concepts Using Steel for Reinforced Concrete Marine Piling, Canadian Eastern Region Conference of National Association of Corrosion Engineers.
Sam Yao et al

Placement Methods for Underwater Repairs. Concrete Repair Bulletin. May/June 1996
Sam Yao and Dale Berner

Richmond San-Rafael Bridge Seismic Retrofit. SEAOC Maui Convention, October 1996
John Vincent

Great Belt and Oresund Fixed Links. CELSOC 1996 Annual Convention San Francisco
Paul Erik Bach

Design and Construction for the Foundation for Underwater World at Pier 39, DFI 11/96 Conference,
George C. Fotinos et al

Deep Foundations Institute Annual Meeting and Conference Keynote Address and '96 Distinguished Service Award honoree
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