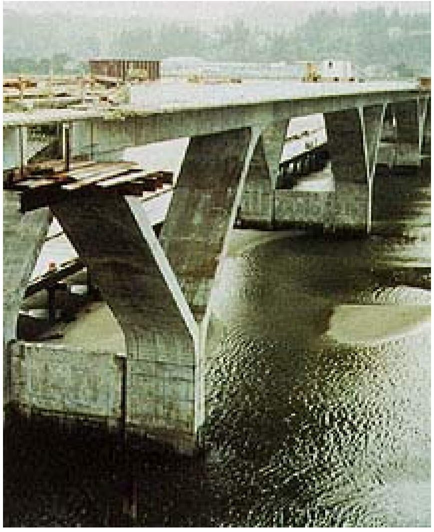
The new Alsea Bay Bridge, on the Coastal Highway of Oregon, replaces an historical bridge built in the 1930's of multiple concrete arches which has been ravaged over its life by corrosion, scour and marine borers.



Y-Leg supports for the approaches.

Knowing the especially corrosive nature of the environment, with salt-laden fogs driven by the persistent onshore winds, the State of Oregon adopted many measures to prevent corrosion in the new bridge-a steel arch with post-tensioned concrete approach spans. The bridge length is nearly 3,000', with a 350' steel arch main span and Y-leg supports for the approaches. The approach spans are constructed segmentally by travelling forms to cast the twin box tube sections. Corrosion protection measures include post-tensioning to reduce cracking, epoxy coated mild steel reinforcement and low permeability concretes.

To attack the problem of bleed during grouting of tendons, especially that which would form voids at the crests of the vertical curves of the ducts, Ben C. Gerwick, Inc. worked with Prof. Weston Hester and Dr. Kamal Khayat of the University of California at Berkeley to extend their development of a thixotropic non-bleed admixture to its application in the grouting of post-tensioning ducts.

Approach span under construction next to badly corroded old bridge.

Tests were arranged on the Alsea Bay Bridge project, for which we were engaged as a specialist consultant. With the cooperation of the owner, the State of Oregon D.O.T. and the contractor, General Construction Co., this thixotropic grout was utilized and proved highly successful.

With the encouragement of the U.S. Federal Highway Works Administration, it was then utilized on the second arm of the cantilevered segmental bridge at Bennet Bay Bridge in Idaho, for which the grouting of the first arm had shown serious problems of bleed and non-filling. SIKA now markets the material as Sikamix 300 SC.

The FIP Guide to Good Practice, for Grouting of Tendons in Prestressed Concrete, 1990 also stresses the recent concern over the surprisingly high level of bad grouting that has been discovered in pre-stressed concrete structures. A preceding publication by FIP "Grouting of Vertical Tendons" had called attention to the serious problems encountered with bleed in vertical ducts, where the wick action of strands aggravates the bleed and can create significant voids at the top.

With the Sikamix 300 SC, a smooth and cohesive yet fluid consistency was obtained, which exhibited a settlement as low as 0 to 0.1 % by height, as opposed to approximately 4% for a typical non-thixotropic grout.

The grout mix used for the Alsea Bay Bridge was proportioned as follows:

- lbs. Type 1/11 Cement
- 18.8 lbs. Flyash Class F
- 39.5 lbs. Water
- 13.0 Fluid ounces Sikamix 300 SC Admixture - Yield 1. 1 6 cu.ft. approx.

Trial test mixes were very useful in determining the proper ratios of admixture and water-cement ratio in order to obtain a mix that pumped easily and did not stiffen with time.

Investigations of the grouted ducts in test installations showed complete filling even at the high point of the ducts. It is believed that thixotropic admixtures such as this will prove of major benefit in assuring the durability of pre-stressed concrete.

The Alsea Bridge is being built for the Department of Transportation of the State of Oregon for whom Howard Needles Tamnen and Bergendorff are design consultants. Ben C. Gerwick, Inc. serves as construction consultant to the State.

Ben C. Gerwick, Jr. and Dale E Berner

The City of Richmond, California is located on San Francisco Bay a few miles from the office of Ben C. Gerwick, Inc. (BCG, Inc.). BCG, Inc. was recently engaged by the Richmond Redevelopment Agency to design a shore protection system to protect the shoreline adjacent to a newly developed housing project. Although the close proximity to the Bay was one of the main attributes of the new development, the City's Department of Public Works was well aware that storms from the south could develop quite high waves along this shoreline. The fact that new houses were to be constructed very near to the Bay made it imperative that the shoreline be protected against erosion and overtopping by waves during such storms.

Storms from South develop high waves along shoreline.

Based on a careful analysis of the site conditions, the shore protection was designed for a breaking wave height of 5.0 feet. The slope of the face of the shore protection was established at 3 horizontal to 1 vertical on the basis of wave runup calculations and seismic stability of the underlying soils.

BCG, Inc. was also asked to help the City solve another problem; namely, how to dispose of or utilize approximately 12,000 tons of concrete rubble which had been accumulated during the process of demolishing the old industrial buildings which previously occupied this site.

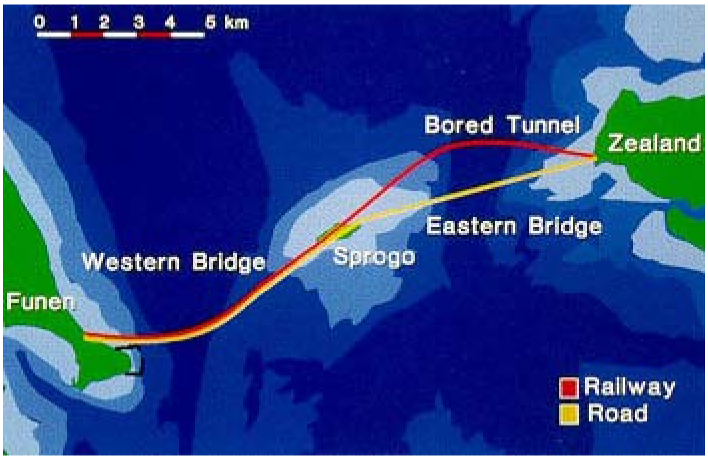
Ben C. Gerwick, Inc. found that it was economical to process the concrete rubble and incorporate it into the shore protection as a 2-foot thick layer of filter material to be placed under a double layer of imported armor rock. The processing of the concrete rubble involved removing the reinforcing steel and crushing the material to a gradation ranging in size from 12 inches down to about 1 inch. The imported armor rock ranged in size from 750 pounds to about 1250 pounds.

Location plan.

The scope of Ben C. Gerwick, Inc.'s work included the design, the preparation of drawings and technical specifications and intermittent consultation during the course of construction. BCG, Inc. was also required to coordinate its work with a Landscape Architectural firm which was responsible for the design of "public access" facilities along the shoreline.

C.R. Firth

A 6.6 km long railway and X-parallel freeway bridge the Western Bridge-forms an important part of the Great Belt Fixed Link in Denmark. The project is one of the largest transportation projects presently under implementation in Europe.



The Great Belt Fixed Link connects the Eastern and Western parts of Denmark.

The overall concept of the Western Bridge is based on on-shore prefabrication of superstructure girders, pier shafts and foundation caissons in controlled environment. The foundation caissons incorporate cellular bases and shafts capped by thick plinths to receive prefabricated piers. The caissons have fixed, identical grid dimensions at the base to promote the use of slipforming, while the cantilevering portions of the cellular bases are varied to suit individual foundation conditions and requirements.

The soil conditions in the Western Channel facilitate direct foundation in glacial moraine clay with good strength at depths of -20 to -28 meters. The seabed preparation for the 62 West Bridge caissons is carried out by a jack-up platform covering the base area for execution of excavation, stone bed placement, compaction and levelling of the stone bed. This platform -called "Buzzard"-was also used for the earlier geotechnical surveys at the individual pier locations.

The "Buzzard" in position for seabed preparation for the foundation caissons.

The caissons are finally installed by a custom built, self propelled barge crane-the "Swan"-with a lifting capacity of 6,000 tons!

The "Swan" Lifting Foundation caisson for joumey to the prepared seabed.

COWIconsult - with whom Ben C. Gerwick, Inc. has been affiliated since 1988 - is the lead consultant for the tender project for the Western Bridge and for the independent control of the contractors detailed design.

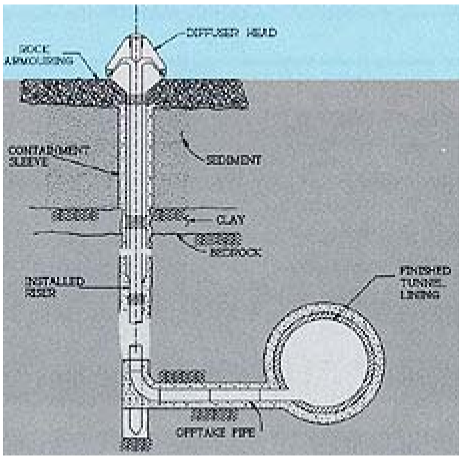
Ben C. Gerwick, Inc. has earlier given advice on the design concepts of the precast concrete foundation caissons and has lately been involved in considerations on a number of important detailed design and construction issues:

- Filter stability for the stone bed, when placed on sand
- Compaction criteria for the stone bed
- Screeding tolerances
- Liquefaction potential of the stone bed under ship collision
- Determination of modulus for the stone bed for evaluation of internal caisson stresses

Ben C. Gerwick, Jr. and Paul Erik Bach

As part of the Massachusetts Water Resources Authority's project for the Boston Harbor Clean-up program, a 9.5 mile long tunnel 24 feet 3 inches in diameter is currently being constructed to carry effluent from a wastewater treatment facility on a nearshore island out to a water depth of 100 feet where it will be dispersed through 55 preinstalled risers.

The construction starts from a 30 foot diameter shaft now being excavated to a depth of approximately 400 feet, using a slurry wall through the overburden, then conventional drill-and-blast techniques.

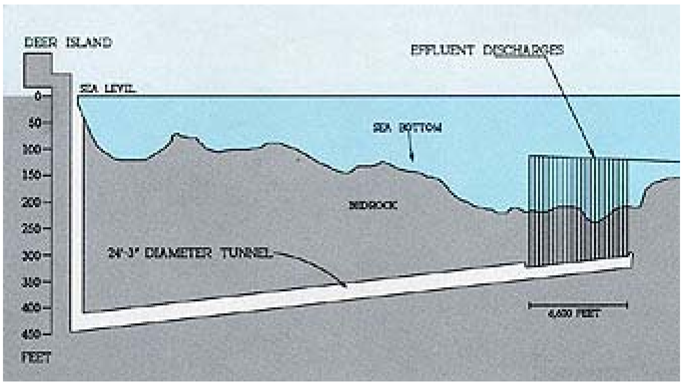


Tunnel to riser general arrangement

A tunnel boring machine will be assembled at the foot of the shaft. Considerable water is expected in some zones, and the tunnel profile runs uphill under a known sedimentfilled valley of glacial origin, to the diffusers located 8.5 miles offshore. The majority of tunneling is expected to be in competent rock although it may pass through some zones of till with water-bearing lenses.

Meanwhile, the 55 diffusers are being installed under a separate contract. Using a large jack-up platform, the contractor will drill and grout steel pipe casings, then insert an inner riser pipe of FRP, grout it into place and affix a diffuser cap, which is temporarily sealed with watertight covers over the ports.

The alignment of the tunnels is chosen to pass approximately 25 feet clear of the pre-drilled risers. When the tunnel machine has passed a riser, a horizontal access hole will be excavated, either by drill or by hand, and an elbow inserted and grouted. Obviously, the precise survey controls for such operations are very demanding.



Profile of the 9-mile long effluent outfall tunnel

The effluent outfall tunnel and diffuser design contracts were awarded to Parsons Brinckerhoff Quade and Douglas who worked with Wholohan-Grill of Sydney, Australia on the marine diffuser riser design. Ben Gerwick, Inc. served as a member of the Technical Review Committee for the Marine Riser construction, and the concrete liner design. Included in this was the development of concrete mix designs and specifications for both the precast concrete liners (which were chosen by the successful bidder) and a cast-in-place concrete alternate. This latter was complicated by the extreme distance over which the concrete would have to be transported.

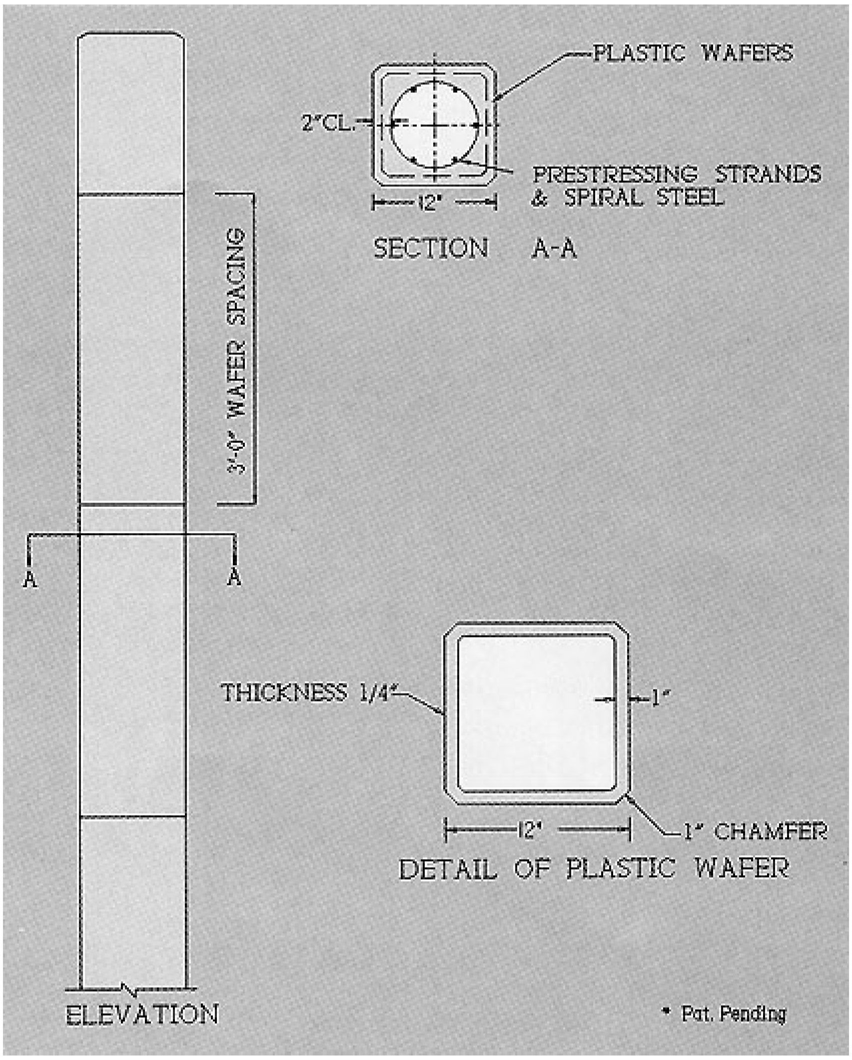
The project is scheduled for completion in 1995.

Ben C. Gerwick, Jr.

The San Francisco lnternational Airport expansion program includes several new buildings and maintenance facilities.

A new international terminal and ground transportation center is at the heart of the expansion and will be complete and in operation for the 50th anniversary of the founding of the United Nations in San Francisco in 1945.

All of the new buildings and structures will be supported on prestressed concrete piles. This is necessary because of the heavy building loads and the presence of soft marine clays, commonly called bay mud, throughout the site. Bedrock at the site varies from 75 ft to over 200 ft deep. A total of 7500 prestressed concrete piles will be required ranging in length from 80 to 140 ft.



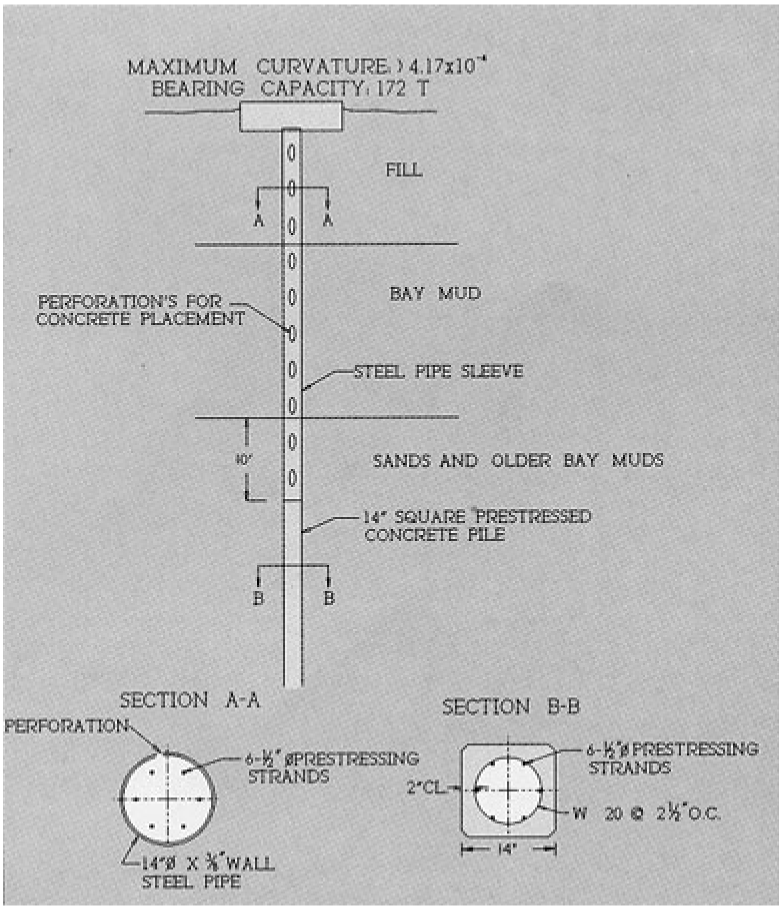
Altemative 1: Composite steel/concrete pile.

A major design consideration for the prestressed concrete piles is the ability of the piles to accommodate seismic loads and distortions. The airport is located within 2 '/2 miles of the San Andreas fault and large ground accelerations are expected. As bedrock accelerations occur and become amplified by the bay muds and other layers of soils, large distortions in the ground results. The embedded prestressed concrete piles will undergo the same distortions and must be able to accommodate the curvatures that occur without failure. The curvatures are especially critical at the intersection of the fills and bay mud layer.

Several concepts are being investigated. Smaller thinner piles are able to accommodate the curvatures better than larger thicker piles because of their reduced stiffness. Using the smaller piles requires the use of greater numbers of piles because of their reduced bearing capacity.

Use of composite steel-concrete piles in the upper zones of greater curvature allows use of moderate size piles. A confinement sleeve is furnished as part of the prestressed pile and is able to accommodate severe curvatures without failure or spalling of the concrete. The sleeve is installed in the prestressing forms and becomes part of the prestressed pile.

Another pile concept being considered for the airport is a prestressed pile with transverse narrow slots formed around the perimeter at regular intervals. This type of pile, known as the "Sonitof" prestressed pile, is able to achieve greater curvatures, since high fiber stresses cannot develop on the surface of the pile during bending because of the presence of the slots.



Alternative 2.- "Sonitof" seismic resistant prestressed concrete pile.*

In all of the prestressed piles, heavy spiral reinforcement will be used to increase pile ductility. Tests performed on full size prestressed concrete piles indicate at least 2% spiral reinforcement is necessary in the piles to prevent failure of the pile at large curvatures while maintaining the bearing capacity of the pile. In some cases, mild steel longitudinal reinforcement will be added to increase the moment capacity in the pile in the upper regions.

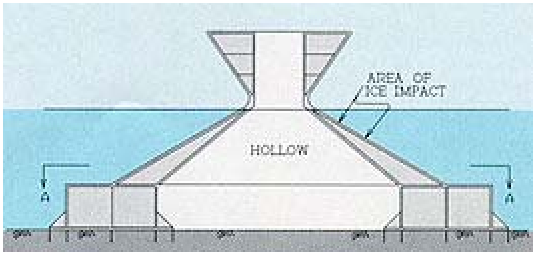
Ben C. Gerwick, Inc. is working as a subconsultant to Dames and Moore, Geotechnical Engineers.

George C. Fotinos

Ben C. Gerwick, Inc. has during the past 10 years been engaged in the development and refinement of advanced concepts for concrete gravity base structure, (GBS), platforms in the Arctic.

Double-shell conical structures represent a very promising concept. Conceptual double-shell conical structures have been developed for several major oil companies. The double-shell conical GBS concept was developed for service in relatively deep water in the U.S. Beaufort and Chukchi Seas.

Design ice features include multi-year ridges with thicknesses of up to 25 m (80 ft). Conically shaped GBS structures can resist large ice features by breaking them in upward flexure against the sloped peripheral wall of the structure.

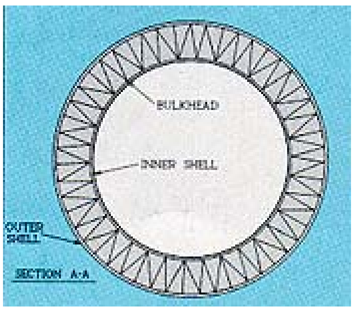


Generic double-shelled conical GBS sub-structure.

Arctic GBS structures require large foundation areas to resist potential ice induced sliding and over-turning. The double-shell configuration can be designed for adequate strength to resist concentrated ice forces, while minimizing material volume, and cost, by elimination of the core of the structure.

The outer peripheral wall of ice resistant GBS platforms must be made strong enough to resist high local punch shear forces on the order of 6 to 10 M Pa (870 to 1,450 psi) over small areas. High local loads can impact anywhere on the ice resistant peripheral wall, and the entire wall must be made strong enough to resist the local ice loads.

As the intensity of ice pressure typically diminish rapidly with increasing loaded area, this leaves the outer shells of a double-shell conical structure with adequate capacity to carry large global loads in three-dimensional membrane action, without the need for expensive internal bulkheads.



Section A-A through double cone

Double-shell conical structures have been analyzed and found to posses good system and member ductility. The three-dimensional shape of the shells, together with the truss action of the interconnecting bulkheads, results in an efficient distribution of forces and efficient development of structural capacity.

Dale E. Berner