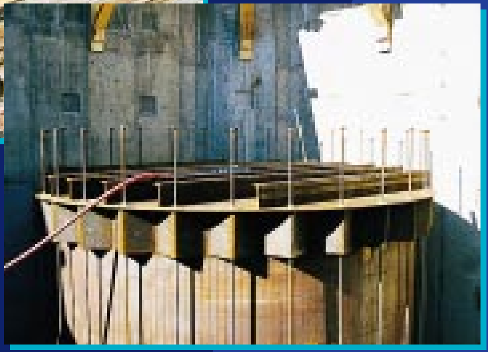
June 1998

Ben C. Gerwick, Inc. NEWS



Ben C. Gerwick, Inc. NEWS

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Cover Picture
Bath-Woolwich Bridge Foundation Construction

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New Publications and Presentations

Ports '98 (Long Beach, CA); ***Design of New Wharf Expansion for the Port of Port Arthur, Texas,*** by George C. Fotinos, Yu-Yi Hsu, Saeed Daniali and David Cruz.

Danish Information Systems Professionals, April 1998; ***World Bridges in Denmark,*** by Paul E. Bach

United States Naval Academy — Bock Memorial Lecture Series, Spring 1998; ***Offshore Construction for the Next Millennium,*** by Ben C. Gerwick

University of San Diego, Workshop on Materials for Infrastructures, March1998; ***Assessing the Remaining Service Life of Structures in the Marine Environment,*** by Ben C. Gerwick and Sam Yao

International Bridge Conference, June 1998; ***Eccentrically Braced and Special Moment Resisting Steel Frame Towers Support Bridge Retrofit,*** by John M. Vincent and Tore Abrahamsen

International Bridge Conference, June 1998; ***Richmond-San Rafael Bridge — Innovative Foundation Retrofit,*** by Thomas Dahlgren and John M. Vincent

Third International Conference on Contract Management, Singapore, March 1998; ***The Role of Innovation in Contract Management for the Next Millennium,*** by Ben C. Gerwick

American Association of Anaesthesiologists, May 1998; ***Seismic Retrofit of San Francisco Bay Bridge,*** by Ben C. Gerwick

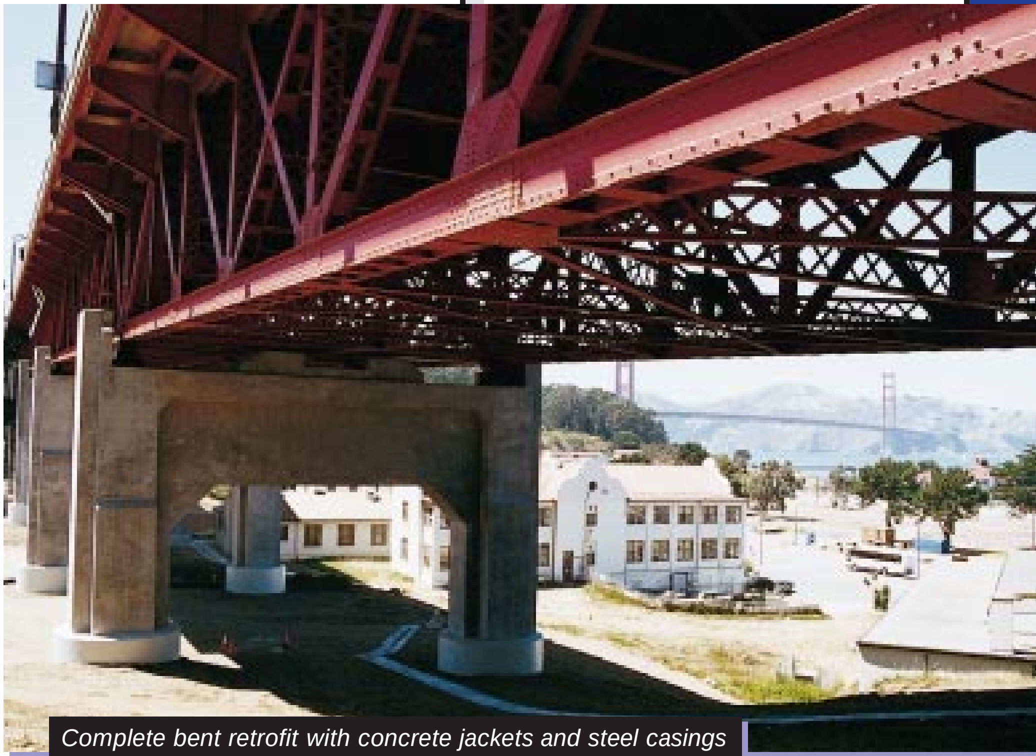
IABSE Colloquium on Tunnel Structures, June 1998; ***Construction of Elements for the Oresund Immersed Tunnel,*** by R. Bittner, P. Nielsen, L-G. Nilsson, C. Noren

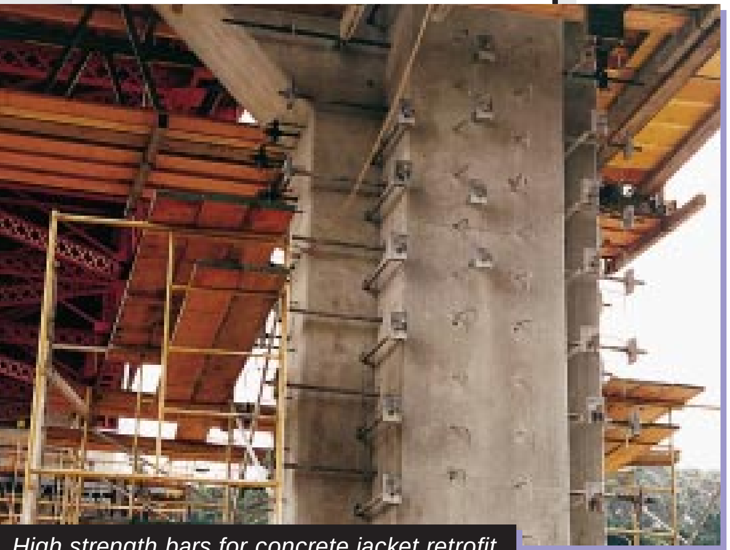
Completion of the Presidio Viaduct

Seismic Retrofit

The seismic retrofit of San Francisco's 59 year old Presidio Viaduct is now complete and the bridge may even look a little better than it did before construction started! Bents were strengthened using concrete jackets in combination with steel casings so that the architectural integrity of the bridge could be retained. By through-bolting high-strength bars, the reinforced concrete jackets are able to provide confinement as well as increased shear resistance. Integral shear keys at the elevation of the pinned bearing assemblies prevent bearing instability and a drop-type failure.

Included in the bearing retrofit were new longitudinal restrainer brackets embedded in the jackets.

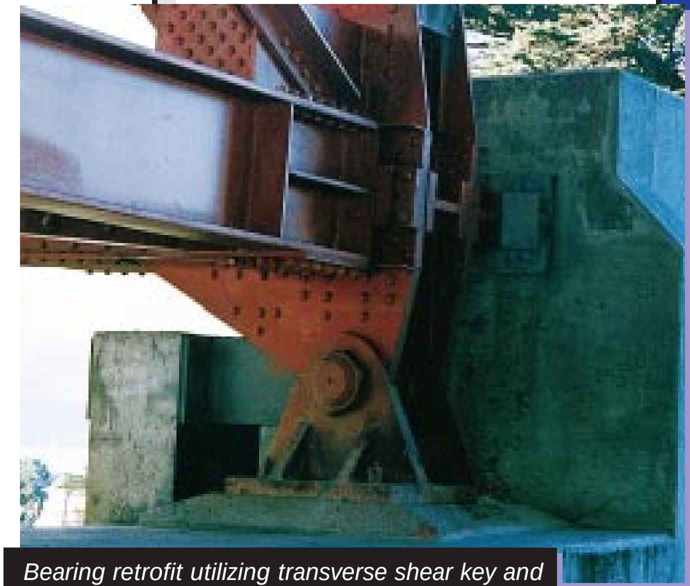

Complete bent retrofit with concrete jackets and steel casings


High strength bars for concrete jacket retrofit

Bearing plates and U-bolts around the existing pins allow the brackets to resist push and pull movements. The bridge retrofit also required:

- truss end-frame strengthening
- bottom chord cable restrainers
- reinforced concrete footing overlays, and
- construction of a large-movement seismic isolation joint

The isolation joint provides a necessary separation between one of the 135-foot long deck-trusses and a concrete on-ramp that frames directly into the side of the truss at midspan. Impacting between the two structures is prevented.


Bearing retrofit utilizing transverse shear key and longitudinal restrainer blanket

Plans and specifications for the retrofit were developed by Ben C. Gerwick, Inc. under an on-call contract with the California Department of Transportation.

John M. Vincent

Bath-Woolwich Bridge

Floating Cofferdams

Constructing bridge foundations under water is an expensive operation and usually represents 40 to 50% of the total bridge cost. One way of reducing this cost is to perform as much of the foundation work as possible on shore by prefabrication and then floating (or lifting) completed elements into position. With this objective in mind, Ben C. Gerwick, Inc. has been working closely with Flatiron Structures Company of Longmont, Colorado to design a floating cofferdam system for the Bath-Woolwich Bridge across the Kennebec River at Bath, Maine.


Launch of concrete cofferdam

The Maine DOT awarded the design-construct contract for the 3,000-foot long 4 lane bridge to Flatiron and Figg Engineers in August of 1997, and shortly there after Ben C. Gerwick, Inc was contacted by Flatiron to design a safe and economical cofferdam system for the six main river piers. Figg's design for the piers was based on using 8-foot diameter drilled shafts. A typical pier foundation will be located in 45 feet of water and will contain 4 drilled shafts supporting a 33-foot by 36-foot by 12-foot deep footing block with the top of the footing about 3 ft below low tide. This design is very efficient because it significantly reduces the depth at which the footing is constructed. However, it does create the problem of how to construct an underwater footing suspended 28-foot off the river bottom.

In order to address this problem and reduce the amount of work in the river, Ben C. Gerwick, Inc. proposed the following construction sequence:

- Pre-install the drilled shafts using a two stage template.
- Construct a precast footing shell on shore and attach a temporary steel follower cofferdam.
- Launch the cofferdam and tow it to the bridge site.
- Position the cofferdam over the drilled shafts and fix it in position with 4 spud piles.
- Lower the cofferdam down over the pre-installed drilled shafts with jacks located on top of the spud piles.


Template for pre-installation of drilled shafts

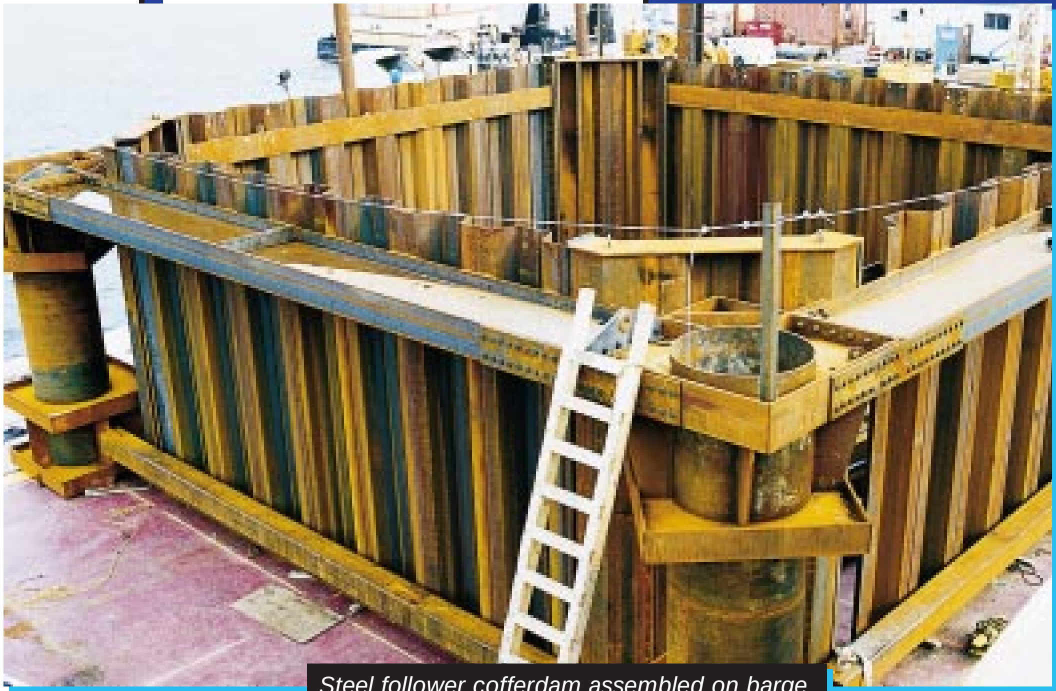
Mating of follower cofferdam to floating precast footing shell

- Lock the footing to the drilled shafts by placing a 4-foot deep tremie seal.
- Dewater the cofferdam and construct the footing and pier shaft in the dry.
- Flood and remove the follower cofferdam for reuse on the next pier.

This construction sequence minimized work in the river and allowed the drilled shaft installation to proceed concurrently with the onshore fabrication and launch of the cofferdams.

Installation of the drilled shafts started in October 1997 and the first precast footing shell with follower cofferdam was launched April 28, 1998. The bridge is scheduled to be completed and opened in late 1999 or early 2000.

Robert B. Bittner



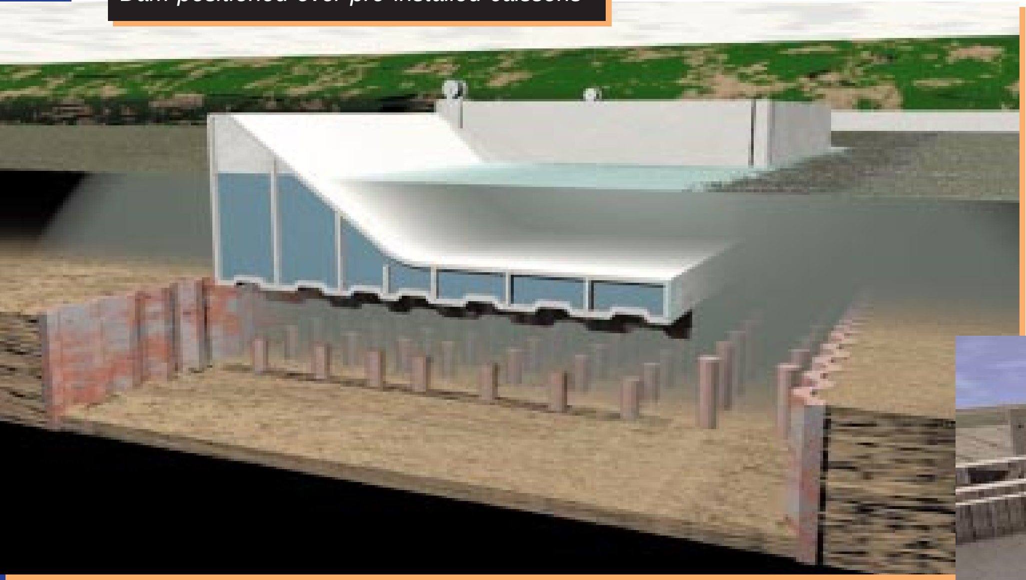
Steel follower cofferdam assembled on barge

Monongahela River — Dam 2

Float-in Dam Construction

Ben C. Gerwick, Inc. is teamed with Bergmann Associates of Rochester, New York, and D'Appolonia of Pittsburgh, Pennsylvania, to design a replacement for Dam 2 on the Monongahela River for the US Army Corps of Engineers. Ben C. Gerwick, Inc. has been working with the Corps Pittsburgh District for the last year, developing and evaluating innovative "In-the-Wet" construction techniques for building locks and dams on the lower Monongahela River.

Dam positioned over pre-installed caissons



"In-the-Wet" construction methods use off-site prefabrication combined with lift-in or float-in of large precast segments onto pre-installed foundations. The segments are locked onto the foundations by underbase grouting and infilling of the segments with tremie concrete. This method offers several advantages over conventional "In-the-Dry" construction:

- Less disruption to river navigation and river flow,
- Lower cost of construction through the elimination of conventional large sheetpile cofferdams and site dewatering,
- Shorter construction time by allowing concurrent construction of dam segments and dam foundations,
- Less environmental impact by reducing dredging and elimination of site dewatering,
- Higher quality by allowing the use of precast concrete produced in a controlled environment.

Ben C. Gerwick, Inc. is taking the lead in designing of the pre-cast dam segments and developing the construction methods and procedures for:

- Casting and launching of the pre-cast dam sements,
- Transport, positioning and immersion of the segments on to the pre-installed foundations,
- Underbase grouting and tremie in-fill of the segments.

The new dam will be a 600-foot long structure with four gate bays. The "In-the-Wet" construction plan calls for breaking the dam into two segments of 333-foot and 265-foot. The segments will be constructed as closed bottom boxes in a two level casting basin. The bottom of the boxes will be recessed for the pre-installed foundation caissons. As each segment is completed, it will be launched by flooding the basin and towed to the site for final outfitting. It will then be positioned over the foundation caissons with a mooring system mounted on the segment. Each segment will then be ballasted down onto 6 landing caissons and leveled with flat jacks. The pile tops and underbase will be grouted, and 8-foot of tremie concrete will be placed in the segment. Each segment will then be dewatered and the remainder of the dam including tainter gates will be completed in the dry.

Completed dam in operation

The final plans and specifications will be completed in October of 1998. Construction is scheduled to start in the Spring of 1999 and be completed in 2002.

Robert B. Bittner

Llagas Creek Bridge Replacement

Staged New Construction

Abutment at "T" intersection

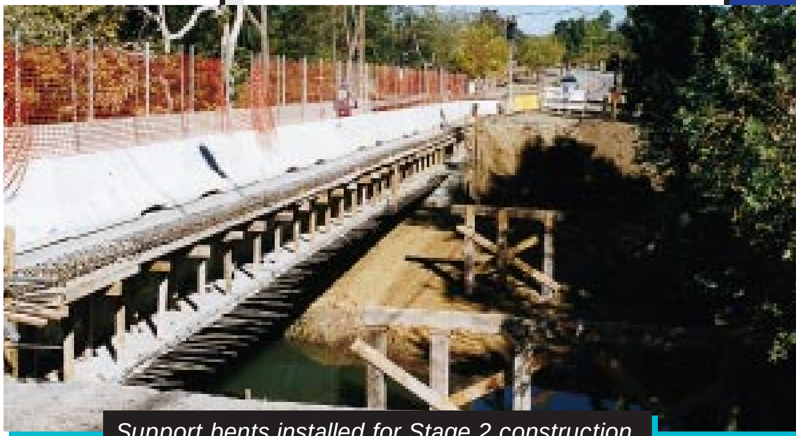
Staged construction and a temporary signalized "T" intersection with two-way traffic over a one-lane bridge is allowing a narrow, three-span structure built in the early 1920's to be replaced with a wider single-span, post-tensioned box girder that's offset from the original alignment by only 4.5 feet. Impacts to neighboring properties and the riparian habitat are thereby minimized.

Cast-in-place construction above the creek is taking place during the usually restricted "wet" season by utilizing steel falsework beams on bents specifically designed to resist flood-stage stream pressures. The bottom of the beams are more than two feet above the design flood water surface to reduce the potential for damage from floating debris during construction. By excluding permanent bents within the creek and adding rock slope protection in front of the abutments, the single-span bridge essentially eliminates long-term maintenance concerns below the roadway deck.

Ben C. Gerwick, Inc., selected by the County of Santa Clara Roads and Airports Department to manage a consultant team providing structural, civil, traffic, electrical, hydrological and geotechnical design services, was directly responsible for the bridge type selection and final design. The bridge was designed for a peak rock acceleration of 0.5g resulting from either a magnitude 7.5 earthquake on the Calaveras Fault or a magnitude 8.0 on the San Andreas Fault. The Calaveras Fault is within 5.5 miles of the bridge site.

To ensure stability during the first construction stage an internal abutment shear key was added to the girder to compensate for the missing external key. In addition, an internal abutment wall supplemented the outside wingwall to fully engage the abutment backfill. This protected the short steel H-piling from excessive demands. The internal wall also compensates for the lower resistance resulting from the tightly curved wingwalls used to accommodate turning movements at the "T" intersection.

One of the most challenging features of a small bridge replacement project is "fitting" the structure into the site. The Llagas Creek Bridge Replacement was no exception. Special attention had to be given to the close proximity of the intersection and the need to maintain traffic at all times. The turning radius of the County's articulated bus fleet had to be accommodated while at the same time ensuring there would be sufficient space for driving piles and constructing the abutment adjacent to the intersection.

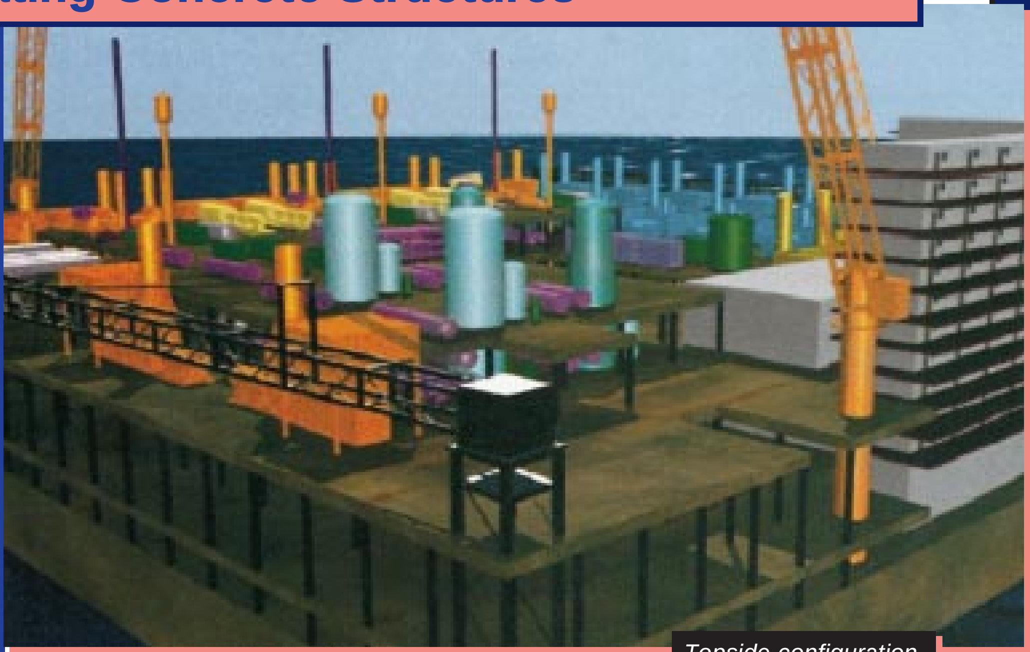


Support bents installed for Stage 2 construction

John M. Vincent

LNG Storage

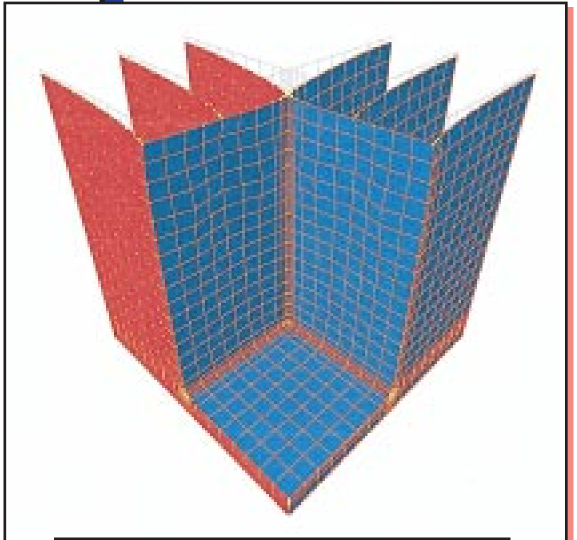
Floating Concrete Structures



Topside configuration

In 1997 Ben C. Gerwick, Inc. conducted a study for Mobil Technology Company, to determine the structural feasibility of storing Liquefied Natural Gas, LNG, in concrete structures afloat in the ocean. LNG reduces the volume of natural gas by approximately 600 times, by liquefying natural gas at approximately - 261˚ F (-163˚ C). This reduction in volume makes it practicable to transport natural gas from remote gas fields to markets across the ocean. While steel vessels are normally used for the storage and transport of LNG, the use of stationary concrete structures would have several advantages in the way of economy and durability. However, before these advantages can be realized, it must be demonstrated that monolithic concrete structures can resist the thermal stresses/strains associated with the very low temperatures of LNG; which was the objective of the study.

The use of monolithic joints in concrete tanks offers both practical benefits and technical difficulties. The benefits include simplified construction, ability to resist loads across the joint, and potentially reduced costs. The difficulties center around the thermally induced stresses within the joint, which can cause failure of the joint, for certain types of joint design. Thermal stresses consist of two broad categories:
1) Internally induced stresses; and 2) Externally induced stresses. The internal stresses are induced by non-linear thermal gradients through an elastic member, which is trying to deform linearly (i.e. plane sections remaining plane).



FEM model for thermal strain

The external stresses (axial, moment, shear) obviously come from external restraint of thermally induced contractions (expansions). In addition to these considerations, it should be noted that both internally-induced, and externally-induced, stresses can be relieved and/or redistributed within the member, by appropriate deformation of the member including sliding, bending, or cracking of the concrete.

3-D finite element models of appropriate concrete structures were developed for both primary, and secondary, LNG containment cases. These models clearly indicated that both primary, and secondary, concrete containment structures would sustain excessive thermal stresses if conventionally configured with right angled joints, and conventionally reinforced. However, these models also indicated, that with practicable modifications to both both configuration and reinforcing, it should be feasible to construct both primary, and secondary, large stationary concrete floating containment structures. These modification include careful selection of materials, geometry, prestressing, liners, insulation, restraint conditions and reinforcing steel layouts.

Dale E. Berner