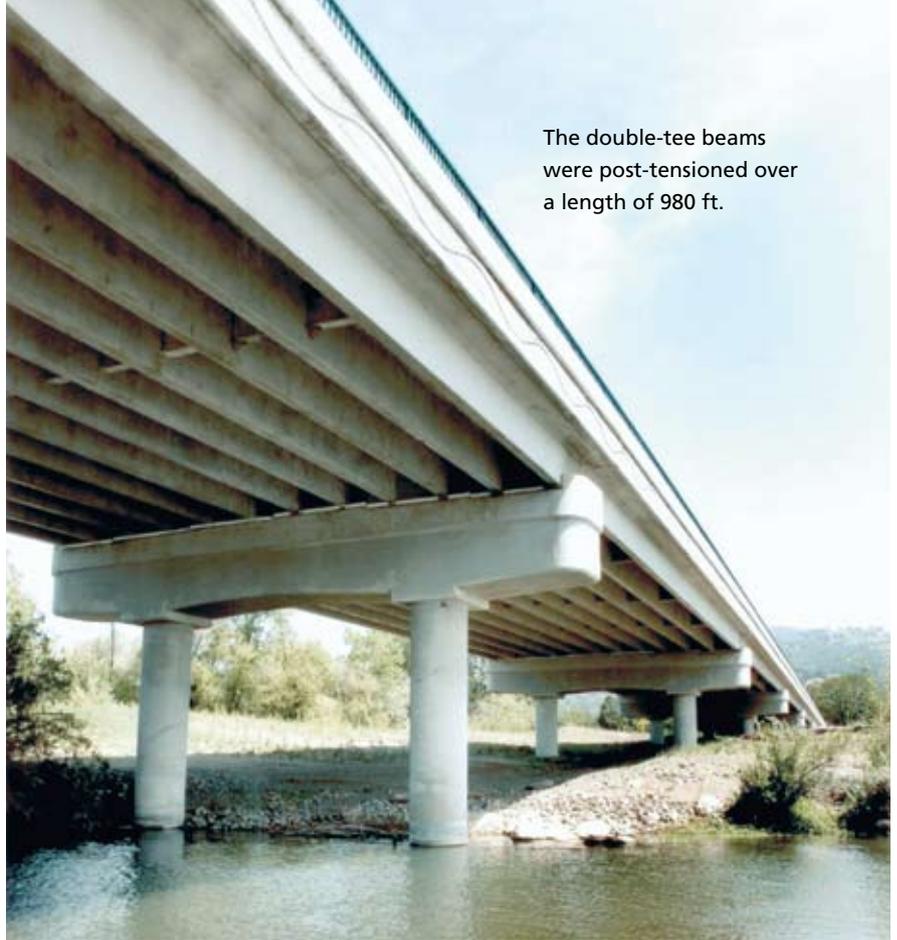




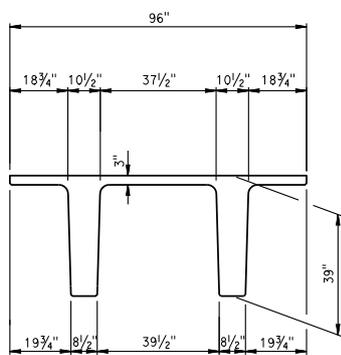
The Russian River Bridge uses non-standard double-tee beams. Photos: Steve Hellon and John Huseby, Caltrans.



The double-tee beams were post-tensioned over a length of 980 ft.

EMERGENCY REPLACEMENT OF THE RUSSIAN RIVER BRIDGE

By Ahmed M. M. Ibrahim, Linan Wang, Tariq Masroor, Minh Ha, and Ofelia Alcantara, California Department of Transportation



Dimensions of the non-standard double-tee beam. Drawing: Ahmed M. M. Ibrahim.

The existing steel truss bridge, built in 1932, over the Russian River in Geyserville, Sonoma County, Calif., was severely damaged during a series of storms in the last two weeks of December 2005. A maintenance crew from the California Department of Transportation (Caltrans) observed lateral rotation of a mid-channel pier and approximately 8 in. of differential settlement between the upstream and downstream sides. The bridge was closed to traffic on January 1, 2006, causing hardship to the local community. It is the shortest route to the high school on the other side of town and closure of the bridge resulted in a 40-minute detour every school day.

Caltrans studied the options of repairing or replacing the bridge. After site geology and scour mitigation studies were completed, Caltrans decided to replace and re-open the bridge to traffic before the next school year. The replacement bridge layout was to have the same overall length, profile, and vertical clearance over the channel as the existing bridge. Matching the existing layout was made mainly to minimize the time in acquiring right of way and to keep the number of permits to a minimum. Raising the bridge profile and consequently extending the bridge length would have led to legal issues.

profile

RUSSIAN RIVER BRIDGE / GEYSERVILLE, SONOMA COUNTY, CALIF.

ENGINEER: California Department of Transportation, Sacramento, Calif.

PRIME CONTRACTOR: CC Meyers Inc., Rancho Cordova, Calif.

CONTRACTOR'S CONSULTANT: R.N. Valentine Inc., Gualala, Calif.

PRECASTER: Con-Fab California Corporation, Lathrop, Calif., a PCI-certified producer

AWARDS: ASCE, *Bridge Project of the Year, Region 9 (California), 2007*; Associated General Contractors, *Excellence in Partnership Award, San Francisco Chapter, 2007*

Sensitive environment and tight construction window led to a precast alternative.

Contract Plans

Caltrans' engineers started the design during the first week of February 2006. The replacement bridge was designed to carry two 12-ft-wide traffic lanes; 8-ft-wide shoulders at each side; and a 5.3-ft-wide sidewalk for an overall width of 49.15 ft. Overall length of the replacement bridge was 980 ft. Hydraulic considerations required the use of fewer spans for the replacement bridge. Eight 102.5-ft-long spans and two 80-ft-long spans at the ends were used. To provide free board clearance for the 100-year design flood, the superstructure depth was limited to 45 in. with a span-to-depth ratio of 27 for the longer spans.

Due to sensitive environmental issues and regulations, the limited construction window was from May to the end of August, and falsework was not allowed in the main channel. These restrictions led to the use of a precast, prestressed concrete bridge as the most suitable alternative. Four standard sections were examined during type selection: I-beams; bulb-tee beams; spread box beams; and adjacent box beams. All four alternatives used simple span beams made continuous with a cast-in-place composite deck. Every



A two-column drop bent cap with aesthetic features was used to support the superstructure.

effort was made to produce a design that used state standard sections and was a fair competition for all precast manufacturers.

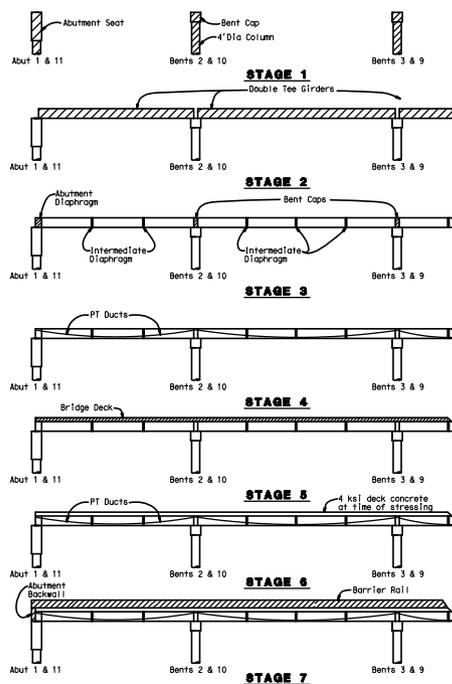
Standard I- and bulb-tee sections did not work due to limited superstructure depth and required the use of non-standard sections. Spread box beams required using less than 2 ft distance between the girders and the use of formwork for deck placement in such a short distance. This section was deemed impractical and was ruled out. Adjacent box beams were the only standard section that met the high span-to-depth ratio. Standard precast, prestressed AASHTO box beams 48 in. wide and 39 in. deep, with a 6-in.-thick, cast-in-place reinforced concrete deck were selected. The adjacent beams were to be transversely post-tensioned at the quarter points. A total of 120 beams would be required.

The precast box beams were to be supported on cast-in-place drop bent caps using two elastomeric bearing pads at each end of each beam. The drop bent caps would have a constant width of 6 ft and a variable depth with minimum dimension of 6 ft. Each drop bent cap was to be supported by two cast-in-steel shell (CISS) pile shafts. Cast-in-steel shell pile shafts were chosen based on their high load-bearing capacity, site conditions, and

hydraulic suitability and were preferred over cast-in-drilled hole (CIDH) pile shafts because of the potential for a cave in during drilling.

A few aesthetic measures were considered for the bridge bent caps, beams, and barriers. The bent caps were designed with simulated capitals, rounded noses and arched soffits to visually reduce their otherwise massive appearance. This effort aided in bringing the bent caps and column shafts into a closer proportional relationship to each other. The smooth vertical face of the precast box beams contributed to the tidy effect of the superstructure exterior, thus complementing the nautical theme of the barriers' surface treatment and context-sensitive handrails.

By mid March, the design package of plans, specifications, and cost estimates was ready for bidding. Bids were based not only on the cost for the work to be done, but also on the product of the number of



Sequence of construction stages. Drawing: Ahmed M. M. Ibrahim.



Lifting the double-tee beams at the precasting yard.

CONTINUOUS POST-TENSIONED, DOUBLE-TEE BEAM / CALIFORNIA DEPARTMENT OF TRANSPORTATION, SACRAMENTO, CALIF., OWNER

POST-TENSIONING SUPPLIER: AVAR Construction Systems Inc., Campbell, Calif.

BRIDGE DESCRIPTION: Precast, prestressed concrete non-standard double-tee beams made continuous using a 6-in.-thick cast-in-place composite deck and two-stage post-tensioning. Eight spans 102.5-ft long and two end spans 80-ft long for a total length of 980 ft

STRUCTURAL COMPONENTS: 60 precast girders, 24 cast-in-steel shells 4-ft-diameter pile shafts, and a deck area 48,216 ft²

BRIDGE CONSTRUCTION COST: \$14.5 million

working days to complete the work and the cost per day shown on the engineer's estimate. This is a simple incentive for the contractor to submit a bid with the least amount of working days.

Contractor's Cost Reduction Incentive Proposal

CC Meyers Inc., general contractor, was awarded the contract on April 11, 2006, to build the bridge in 80 days. The very next day, the general contractor, along with the consultant designer and precast manufacturer, submitted a Cost Reduction Incentive Proposal (CRIP) to use a non-standard, double-tee precast, prestressed concrete beam with multiple stages of post-tensioning in the field. The proposed non-standard double-tee beam was twice as wide as the original design (8 ft compared to 4 ft), which resulted in half as many girders per span than in the original design (total of 60 girders compared to 120 girders). A standard double-tee section is typically suitable for 40 to 65 ft span lengths and was not an option in Caltrans approved beam sections for such long spans used for the replacement bridge.

The proposed beam design used two-stage post-tensioning to maintain continuity of the superstructure under applied loads. Cast-in-place diaphragms



A 6-in.-thick deck was cast-in-place before applying the second-stage post-tensioning.

The contractor's consultant submitted superstructure design plans to Caltrans by the end of April for review and approval. Caltrans engineers performed independent calculations using time-dependent concrete properties to check stresses in the double-tee beams during pretensioning, erection, first post-tensioning, deck casting, and second post-tensioning construction stages. The independent check also included a review of deflections at various construction stages, long-term camber, and superstructure seismic response. The Caltrans independent check resulted in modifications to the amount and location of the prestressing.

Moreover, post-tensioning a 980-ft-long continuous double-tee beam frame resulted in large longitudinal forces being transferred to the substructure pile shafts under service loads. These were not part

Special precast, prestressed concrete, double-tee beams with two-stage post-tensioning were used.

between beams and first stage post-tensioning were used to create continuity under the weight of the 6-in.-thick deck slab. A second stage post-tensioning was applied to carry the bridge superimposed dead and live loads. Original superstructure depth was maintained in the proposed design and no changes were made to the substructure design as a consequence. Not only was the double-tee section non-standard, but also the two-stage post-tensioning was not a standard practice for the precast industry in California.

Caltrans immediately evaluated the proposal and approved the concept primarily to reduce construction time and increase possible cost savings. Closure of the nearest precasting yard and the difficulty of transporting long girders on the local roads made this CRIP necessary.

of the original design. Caltrans requested the superstructure to bent cap connection be modified at the two outer bents to allow for longitudinal movement during post-tensioning without transferring any displacement to the pile shafts. Metal plates with a greasy surface were used to allow for superstructure sliding with minimal force transfer to the supporting bent caps. After initial shortening of the superstructure and grouting of the post-tensioning ducts, the connection was locked in place.

Caltrans engineers cooperated with the contractor's consultant to review and approve the design and detailing of the proposed double-tee beams in two weeks.

Accelerated Construction

The general contractor mobilized equipment and demolished the existing

pony truss bridge while the proposed alternate superstructure design was prepared by his consultant and reviewed and approved by Caltrans. A temporary trestle was built on the upstream side of the bridge to provide access to the work site for demolition of existing bridge and the construction of the new bridge.

Construction started in early May with driving the CISS pile shafts and building the drop bent caps. Pile load testing was conducted at two different bent locations to determine actual in-situ soil resistance. No reduction in driving length was gained however, as better than estimated soil skin friction and end bearing were not warranted.

In the meantime, new beam formwork was built and the double-tee beams were fabricated and transported to the site in May and June. Erection of the beams was completed in July. The cast-in-place diaphragms and intermediate diaphragms were cast in early August, followed by the first-stage post-tensioning operation. The deck was cast and the second-stage post-tensioning took place three days later. Work around the clock resulted in the bridge opening to traffic on August 17, 2006, one week before the school year began, to the delight of the local community.



Testing of pile shafts for possible reduction in driving length.

Ahmed M. M. Ibrahim, Linan Wang, Tariq Masroor, and Minh Ha are senior bridge engineers, and Ofelia Alcantara is a supervising bridge engineer with the California Department of Transportation, Sacramento, Calif. The authors appreciate the contribution of Jeffery Thorne.

HAMILTON FORM CREATES FUNCTION

2

CASE STUDY

ESCAMBIA BAY BRIDGE

"The forms work perfectly. Hamilton Form builds high quality, well-thought-out forms that have contributed to the success of many of our projects."

*Don Theobald
Vice President of Engineering
Gulf Coast Pre-Stress*



The Challenge:

Gulf Coast Pre-Stress — which itself was reeling from Katrina's impact — was awarded four major bridge projects damaged by hurricanes, including Escambia Bay Bridge near Pensacola, Florida.

The bridge elements include a heavily reinforced pile cap with a unique "on-site," cast tension connection to the precast/prestressed pile. This *moment connection* was designed to provide a continuous beam configuration and provide resistance to uplift from potential future storm surges.

The Solution:

Hamilton Form built the custom formwork including the piling, pile cap and BT78 forms. The pile cap form design includes two-piece, tapered voids at the connection locations to allow the top to be "popped" after initial preset of the concrete to accommodate final stripping.

The Results:

The forms worked perfectly. The new bridge added an additional line of traffic in each direction and was fully opened ahead of schedule.

To learn more about Hamilton Form visit www.hamiltonform.com



Hamilton Form Company, Ltd.

7009 Midway Road • Fort Worth, Texas 76118 • P-817.590.2111 • F-817.595.1110



Silica Fume Association

The Silica Fume Association (SFA), a not-for-profit corporation based in Delaware, with offices in Virginia and Ohio, was formed in 1998 to assist the producers of silica fume in promoting its usage in concrete. Silica fume, a by-product of silicon and ferro-silicon metal production, is a highly-reactive pozzolan and a key ingredient in high performance concrete, dramatically increasing the service-life of structures.

The SFA advances the use of silica fume in the nation's concrete infrastructure and works to increase the awareness and understanding of silica fume concrete in the private civil engineering sector, among state transportation officials and in the academic community. The SFA's goals are two-fold: to provide a legacy of durable concrete structures and to decrease silica fume volume in the national waste stream.

Some of the recent projects completed by the SFA, under a cooperative agreement with the Federal Highway Administration (FHWA), include:

- The publication of a *Silica Fume User's Manual*—the manual is a comprehensive guide for specifiers, ready mixed and precast concrete producers, and contractors that describes the best practice for the successful use of silica fume in the production of high performance concrete (HPC).
- The introduction of a Standard Reference Material (SRM)[®] 2696 Silica Fume for checking the accuracy of existing laboratory practices and to provide a tool for instrument calibration. This SRM is available from the National Institute of Standards and Technology (NIST).

A much anticipated research program nearing completion by the SFA is the testing of in-place silica fume concrete under service conditions. At the conclusion of this research the results will demonstrate the benefit of silica fume concrete's unparalleled long-term performance. For more information about SFA, visit www.silicafume.org.

How to do it in Precast...

Q How do you connect the rebar?

A Use the... **NMB Splice-Sleeve System.**

Q How is the moment connection made?

A All you need is an emulative detail, reconnect the concrete and rebar.

Edison Bridge, Fort Myers, Florida

cross-section

Mill Street Bridge, Epping, New Hampshire

NMB SPLICE SLEEVE

SPLICE SLEEVE NORTH AMERICA, INC.
 192 Technology Drive, Suite J • Irvine, CA 92618-2409
 PHONE: 949-861-8393 • FAX: 949-861-8419 • e-mail: info@splicesleeve.com
WWW.SPICESLEEVE.COM



STAY CABLES

FIGG, engineer for
Maine Department
of Transportation's
Penobscot Narrows
Bridge & Observatory.
Photo: FIGG

now YOU SEE US...

PRESTRESSED DECK PANELS

Sumiden Wire is the reliable
strand supplier with **TWO**
strategically located facilities
that **DELIVER NATIONWIDE** and
provide experienced technical
and engineering support.

YOU CAN COUNT ON US!



now YOU DON'T.

Epoxy coated strand (ECS) is filled
and is an ASTM product



SUMIDEN WIRE PRODUCTS CORPORATION

1412 El Pinal Drive • Stockton, CA 95205 • 209.466.8924 • Fax 209.941.2990
710 Marshall Stuart Drive • Dickson, TN 37055 • Toll Free 866.491.5020 • 615.446.3199 • Fax 615.446.8188

Stressing Our Commitment To You Everyday!

www.sumidenwire.com

PRESTRESS / PRECAST • STAY CABLE • POST-TENSION