Cast-in-Place Reinforced Concrete Slab Bridges:

Making a Great Solution Greater

Cast-in-place reinforced concrete slab bridges continue to be the most economical, durable, and easy-to-design bridges in use today. These bridges are often supported on different types of foundations, or cast in various shapes, or faced with different materials, but the basic function remains the same: the slab serves as the main superstructure member, requiring no other beams or girders to carry the loads.

Reinforced concrete slab bridges span roads and railroad tracks, rivers and streams across the United States, in turn carrying cars and trucks, pedestrians, and trains. Their popularity stems largely from their low cost of construction, their durability, their simplicity, and the versatility they present to bridge owners and designers.

Despite the long history, relative simplicity, and economy inherent in slab bridge technology, bridge engineers are building new design and construction innovations into this "workhorse," thereby creating stronger bridges that can be built faster, longer, and more slender.

The cast-in-place reinforced concrete slab bridges presented here represent recent innovations and show their exceptional constructibility.

"We almost always use reinforced concrete slab bridges when we have span lengths of around 25 feet; we no longer used T-beam and girder bridges at all. Design charts for traditional slabs—and for post-tensioned and voided slabs—make our bridge design very straightforward."

— Michael Cullen, P.E.
Senior Bridge Engineer, Caltrans

Struve Slough Bridge: FASTER Reconstruction

The October 17, 1989 Loma Prieta earthquake shook the two deck-and-stringer Struve Slough bridges on Highway 1 in California so intensely that the bridge piers punctured the 6.5-inch-thick deck slab as the stringers below the deck separated from the piers. Both bridges partially collapsed.

The Struve Slough Bridge carries thousands of cars and trucks per day between Santa Cruz, Watsonville, and Monterey. The bridge collapse caused a major inconvenience to area travelers, and it was imperative that the bridge be rebuilt in the shortest time possible.

After evaluating several alternatives, the California Department of Transportation (Caltrans) concluded that a cast-in-place reinforced concrete slab was the most cost-effective and fastest way to rebuild the two bridges. *(continued inside)*

Cleveland Road Bridge Replacement: LONGER Single Span

A number of conflicting requirements faced the bridge owner and engineer on the replacement bridge over Biscayne Point Canal in Miami Beach, Florida. The replacement bridge required increased navigational clearance for boaters below, yet required decreased horizontal profile to improve visibility for traffic above.

"We were very pleased to be able to satisfy the public's preference for a bridge with no center supports that could impede boat traffic in the canal."

— Israel Magrisso, P.E., Senior Project Manager
Florida Department of Transportation

The solution was a shallow (16-inch-thick), cast-in-place reinforced concrete slab bridge. Traditional concrete slab bridge spans are typically less than 50 feet long and have a typical span length-to-depth ratio of 43:1.

The key to this exceptionally long single span (65 feet) is two-way action achieved by combining conventional reinforced concrete design with post-tensioning. The slab structure distributes the loads to both the parapets and abutments through #10 (#32) steel reinforcing bars at 6 inches on-center (top and bottom), post-tensioning tendons, and concrete with a compressive strength of 5,500 psi. The parapets are monolithic with the bridge deck slab and serve as structural elements.

PVC pipes were placed 12 inches on-center in the deck slab to create voids and thereby reduce the weight of the structure. Large-diameter PVC sleeves embedded within the sidewalks serve as sleeves for the water, gas, and electric utilities.

Photo © Kim Walker Stanberry

The bridge has become a true visual asset to the surrounding communities. But one of the biggest advantages of the long span length was that this bridge was built without impacting the endangered Johnson's Seagrass within the channel, or the manatees that frequently swim there.

Cleveland Road Bridge Replacement
Miami Beach, Florida

Owner: ***Florida Department of Transportation, District 6***

Engineer: ***Stanley Consultants, Inc., West Palm Beach, Florida***

Contractor: ***Lanzo Construction Company, Coral Gables, Florida***

(continued from cover)

Struve Slough Bridge...

"Caltrans has standard design charts for the superstructure," says Michael Cullen, P.E., Senior Bridge Engineer with Caltrans. "Therefore, we only needed to custom-design the substructure and the connections to bring them up to then-current seismic standards. This saved a tremendous amount of time."

Caltrans designed the 2 replacement bridges and prepared the plans and specifications in just 10 days. Caltrans then offered an incentive/disincentive construction contract.

General contractor CC Meyers removed the old bridges, built the new bridges and approaches, removed a temporary access road, and restored the site in just 55 days, a full 35 days earlier than the contracted schedule. Of that time, it took 27 days to drive 200 new support piles,

Woolf Avenue Bridge: THINNER Works Better

The old Woolf Avenue Bridge over U.S. Highway 6 and the CRANDIC Railroad in Iowa City, Iowa, was supported on 30-inch-deep steel I-beams, which only left a 14.5-foot clearance between the bridge and the highway below. The bridge had been hit several times by trucks (twice closing the bridge for extensive repairs). It had also deteriorated to the point that traffic loading had to be limited.

"The slender cross section you can achieve with a concrete slab bridge is aesthetically pleasing. It also greatly improves the functionality for highway crossings like the Woolf Avenue Bridge and for water crossings subject to flooding."

— Rick Fosse, P.E., City Engineer, City of Iowa City

Because of the 71-foot span length, bridge engineers NNW, Inc. originally considered replacing the bridge in-kind. "But we thought it would be a shame not to improve on the clearance problem," says Steve Jacobsen, P.E., President of NNW. "We knew we needed a thinner structure, so we performed some structural modeling to see if a reinforced concrete slab would work."

It wasn't until engineers tried inclining the support piers (concrete-encased steel piles) that the cast-in-place slab bridge became technically feasible. Inclining the piles shortened the span length to 63 feet. But this length still exceeded the practical span length for the traditional solid reinforced concrete slab bridge. Therefore, to reduce dead weight, a "voided slab" was designed to be a mere 28-inches thick, and allowed the vertical clearance to increase to 16.5 feet.

The voided slab, in effect, acts structurally as beam elements, in which the reinforced concrete at the top and bottom of the slab resists the majority of the bridge forces. Casting 16-inch-diameter cardboard tubes 24 inches on-center created the voids.

Because Iowa City uses deicing chemicals on its roads and bridges in the winter, epoxy coating of the steel reinforcing bars was used to increase the long-term durability of the structure. The new bridge now creates a slender, elegant gateway into Iowa City.

Woolf Avenue Bridge
Iowa City, Iowa

Owner:	***City of Iowa City***
Engineer:	***NNW, Inc., Iowa City, Iowa***
Contractor:	***Iowa Bridge and Culvert, Inc., Washington, Iowa***

...FASTER Reconstruction

the most difficult part of the project. During steel reinforcing bar placement, ironworkers worked vigorously to place the bars for both bridge slabs in just 11 days.

Besides working around the clock, the contractor implemented several other time-saving innovations. For example, bridge camber was increased by 50 percent so that formwork could be removed in 7 days, in lieu of the 10 days in the contract. The contractor also suspended the formwork from the piles, thereby eliminating the need to erect a more elaborate support system.

Struve Slough Bridges
Watsonville, California

Owner:	***California Department of Transportation***
Engineer:	***California Department of Transportation***
Contractor:	***CC Meyers, Rancho Cordova, Calif.***

Cast-in-Place Reinforced Concrete Slab Bridges: Many Ways to Optimize Design and Construction

The past has seen many exciting innovations and improvements in the realm of cast-in-place reinforced concrete slab bridges. Innovations such as "voided" slabs, the use of high-strength concrete and lightweight aggregate, post-tensioning, and formwork systems all have been employed in various combinations to make a great solution greater!

Simple components mean concrete slab bridges can be built quickly and cost effectively.

- Straightforward formwork erection, reinforcing bar placement, and concrete placement.
- Nationwide network of ready-mixed concrete suppliers, reinforcing steel fabricators, and ironworkers available near project sites.
- Construction tolerances that allow quick adjustments to actual field conditions.
- Use of local materials and labor.

Concrete slab bridges offer unparalleled versatility in design and construction.

- Typical span length-to-depth ratios in the range of 20:1 to 40:1, half that of deck-and-stringer bridges.
- Increased vertical clearance below for traffic or high water.
- Reduced bridge approach lengths, saving right-of-way and embankment material.

Long-term performance and maintenance can be superior to other bridge types.

- Greater seismic and vehicle impact resistance because components act as a unified whole.
- Inherent redundancy in internal structure allows load redistribution if portions of the structure are damaged.
- Greater stiffness means reduced vibrations under traffic loadings.
- Periodic cleaning and painting are not necessary.
- Fewer or no ledges and crevices that can collect dirt, debris, and wildlife.

And reinforced concrete slab bridges look great!

- Substructure and superstructure style is coherent; materials are uniform.
- Utility lines can be embedded within the slab.
- The underside of the superstructure forms a smooth surface.
- Slenderness and transparency for context-sensitive design.

CRSI

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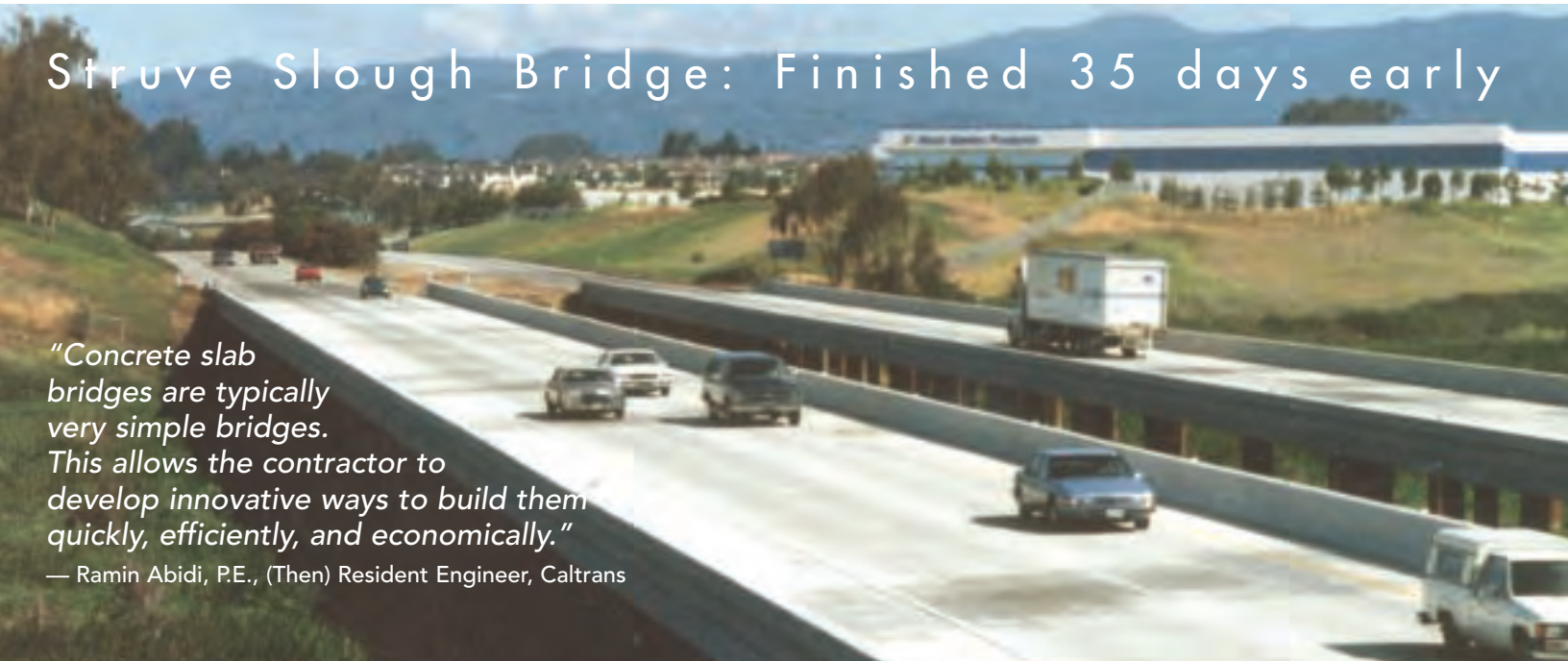
Design by Convey

Struve Slough Bridge: Finished 35 days early



"Concrete slab bridges are typically very simple bridges. This allows the contractor to develop innovative ways to build them quickly, efficiently, and economically."

— Ramin Abidi, P.E., (Then) Resident Engineer, Caltrans