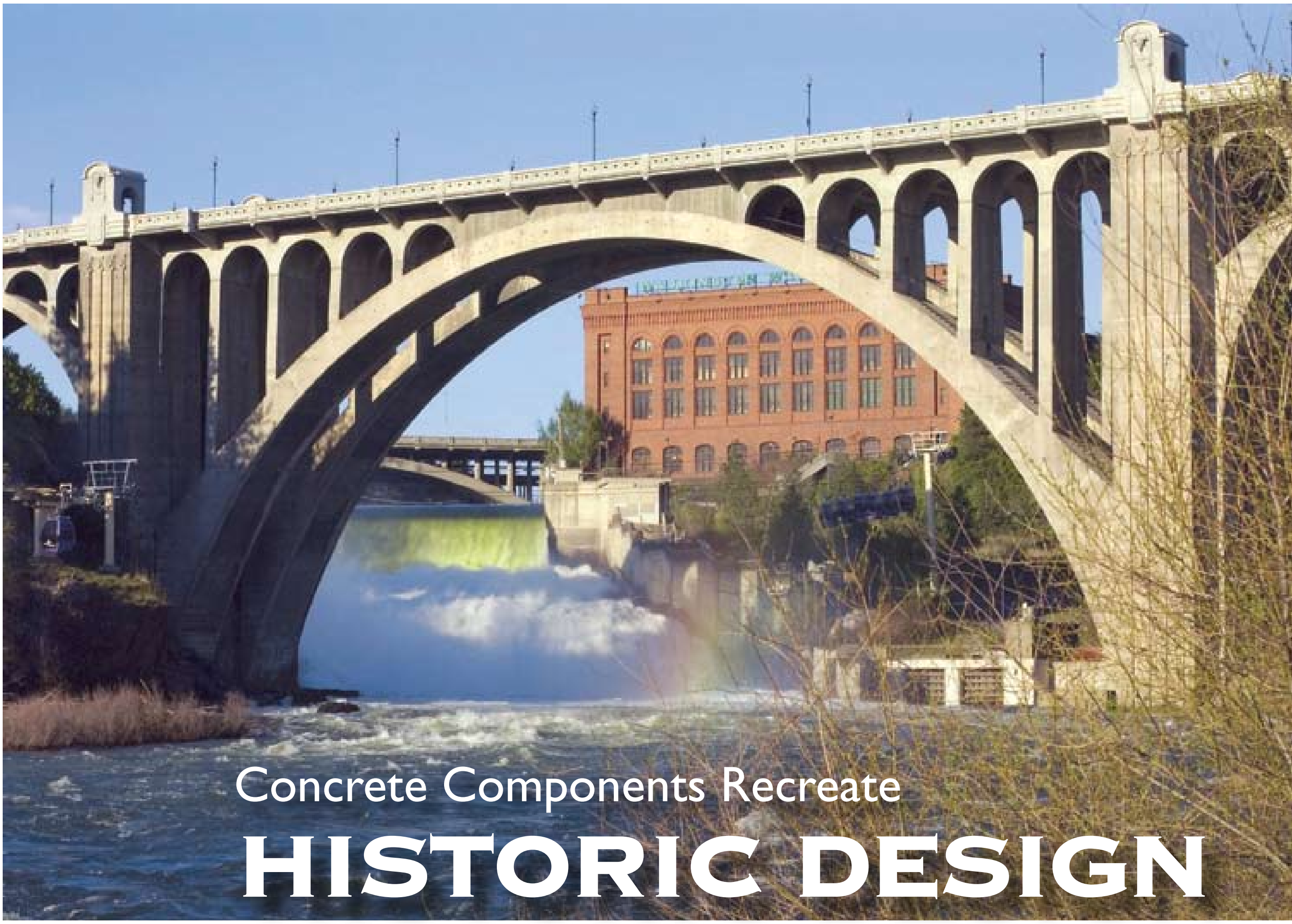


Concrete Components Recreate HISTORIC DESIGN

by Leora Casey, David Evans and Associates, Inc.

The replicated railings were created with precast concrete and connected with cast-in-place concrete posts.

The Monroe Street Bridge in downtown Spokane, Wash., has provided a critical north-south traffic link within the city since 1911. At almost a century old, the bridge was near the end of its useful life when a rehabilitation project was launched in 2001. The project posed a number of significant challenges due to historic preservation requirements, environmental concerns, and the functional aspects of replacing a bridge that spans a 136-ft-deep river gorge. The project designers used a combination of precast and cast-in-place concrete components to meet these requirements.

The existing design featured a three-span concrete arch structure with reinforced concrete approaches. The total length is 896 ft with a main river span of 281 ft and two side spans of 120 ft. Four original pavilions over the sidewalks at the main piers projected into the travel lanes and had been damaged repeatedly by vehicle impacts.

profile

MONROE STREET BRIDGE / SPOKANE, WASHINGTON

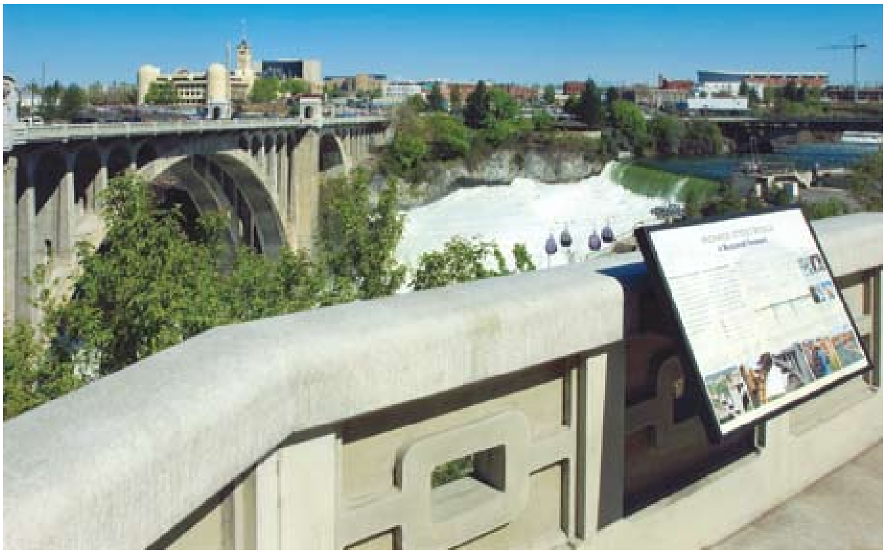
ENGINEER: David Evans and Associates, Inc., Salem, Ore., and Spokane, Wash.

PRIME CONTRACTOR: Wildish Standard Paving, Eugene, Ore.

CAST-IN-PLACE CONCRETE SUPPLIER: Central Pre-Mix Concrete Co., Spokane, Wash.

AWARDS: *2003 Honor Award, Historic Preservation, American Planning Association, Washington Chapter; 2006 Gold Award for Engineering Excellence, American Council of Engineering Companies, Washington; and 2006 PCI Design Award, Best Rehabilitated Bridge*

Precast, prestressed concrete panels and railings combine with cast-in-place superstructure on historic Spokane bridge



Historic plaques were attached to alcoves provided at key overlooks to highlight the historic nature of the bridge.

A study of the bridge's condition found that the superstructure was in very poor condition. As a result, city officials began a major 5-year, $18-million project to preserve this historic city landmark, which is used by an estimated 25,000 vehicles daily, plus bicycles and pedestrians. The essence of the program involved replacing the entire deck system, the spandrel arches, and columns down to the main arches, and the viaduct on the north end of the bridge. It also included moving the pavilions away from the roadway and repairing other damage throughout the bridge.

A key element of the project was to ensure this work maintained the historic features and extended the useful life of the bridge by at least 75 years. A 20-year option, which would have required minimal work, was also considered but the city leaders decided that a longer-term perspective was required.

The project presented several challenges for the design team, including multiple agency coordination, historic preservation, strict environmental requirements, unusual construction details, deteriorating conditions, traffic management, and safety. The designers held a number of meetings and received feedback from citizen groups of various kinds. This helped produce a realistic design and construction plan for successful rehabilitation, while maintaining the important historical integrity of the bridge.

'The design needed to meet federal and state requirements to secure funding.'

Because of the historic nature of the bridge, the design needed to meet federal and state requirements to secure funding from these agencies. The design team worked closely with the State Historical Preservation Office and the local Landmarks Commission to determine the best ways to meet traffic-safety requirements and provide economical construction. This process showed that the use of precast, prestressed concrete for the sub-deck structural system and precast concrete for the historically significant pedestrian railing were the best option.

Six Systems Considered

Six deck-system alternatives with varying span lengths and topping combinations were evaluated. The selected option features a cast-in-place deck made integral with 408 precast, prestressed concrete sub-deck panels and 1776 ft of historic railing reproductions. The deck panels were 19.6 ft long, 4 ft wide, and 12 in. deep, with a 5-in.-thick, cast-in-place concrete topping. This choice was based on cost, ease of erection, and serviceability. The spandrel arches, columns, and crossbeams were made from cast-in-place concrete to maintain

THREE-SPAN CONCRETE ARCH / CITY OF SPOKANE, OWNER

BRIDGE DESCRIPTION: Rehabilitation of a three-span concrete arch with a total length of 896 ft and a main span of 281 ft using a combination of precast and cast-in-place concrete components

PRECASTER: Central Pre-Mix Prestress Co., Spokane, Wash., a PCI-Certified Producer

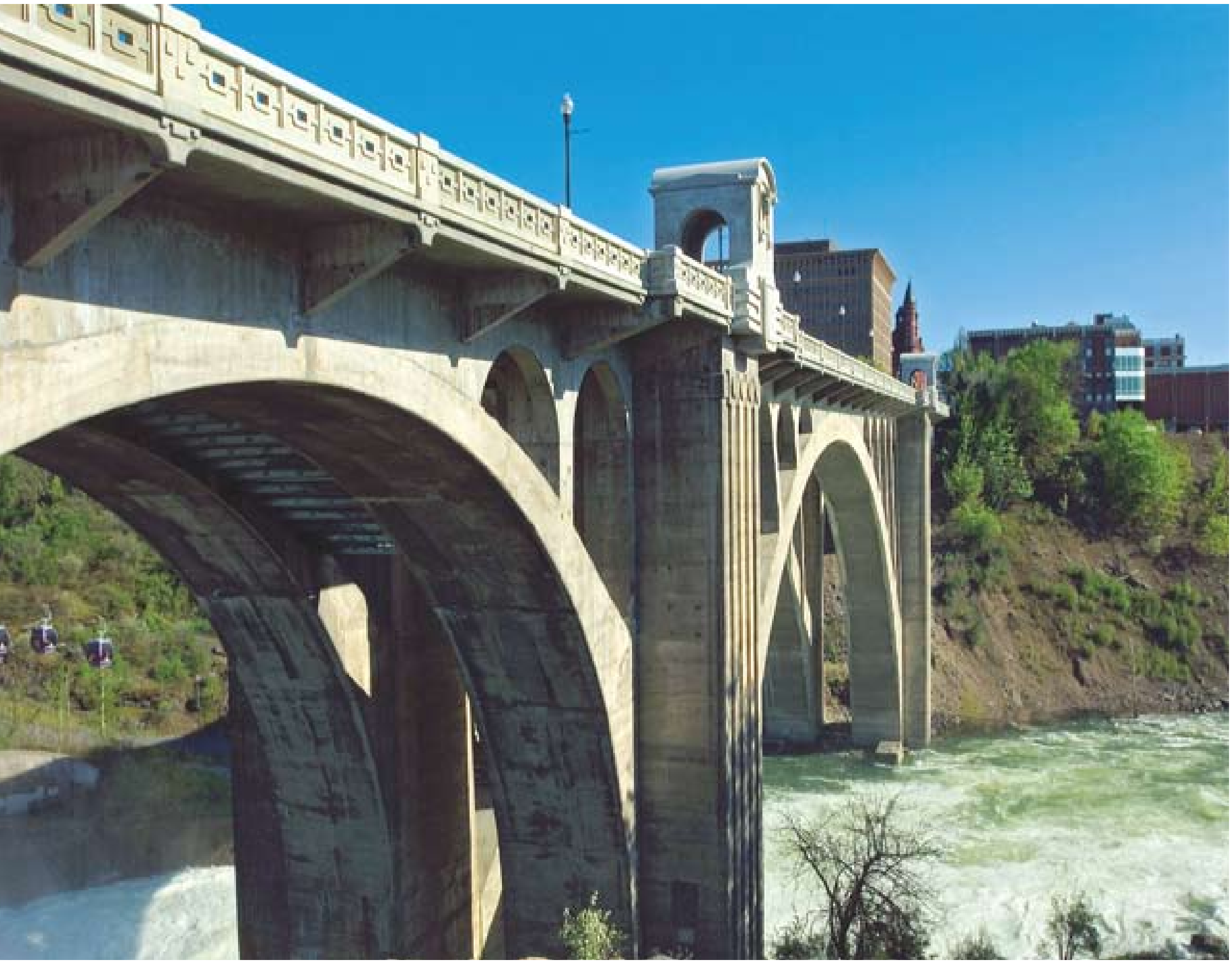
STRUCTURAL COMPONENTS: Cast-in-place concrete spandrel arches, columns, and crossbeams; precast, prestressed concrete sub-deck panels; precast concrete railings; and cast-in-place concrete deck

BRIDGE CONSTRUCTION COST: $13.3 million the historical integrity. The new superstructure was designed to allow future widening from four lanes to six.

The precast, prestressed concrete sub-deck system was a great benefit to the contractor due to the relatively inaccessible location. Its use allowed heavy equipment to travel out on the deck earlier than other options, thereby, accelerating the construction.

The ornamental railings on the bridge incorporate an intricate, historically significant "chain" motif. Precasting these elements was readily recognized as the best choice to attain a consistently accurate and high-quality replication of the original railing as well as helping to meet the schedule. The railing sections were cast upside down in metal forms to achieve an extremely smooth handhold top surface.

The precast, prestressed concrete sub-deck system allowed heavy equipment to travel out onto the deck early and accelerated construction.



The Monroe Street Bridge in Spokane, Wash., was rehabilitated with cast-in-place concrete spandrel arches, columns, and crossbeams; precast, prestressed concrete sub-deck panels; precast concrete railings; and a cast-in-place concrete deck.

Self-consolidating concrete created smooth surfaces and substantially reduced voids.

Decorative pavilions were placed above the piers out of the line of the roadway to add visual interest to the design and replicate the original pavilions.

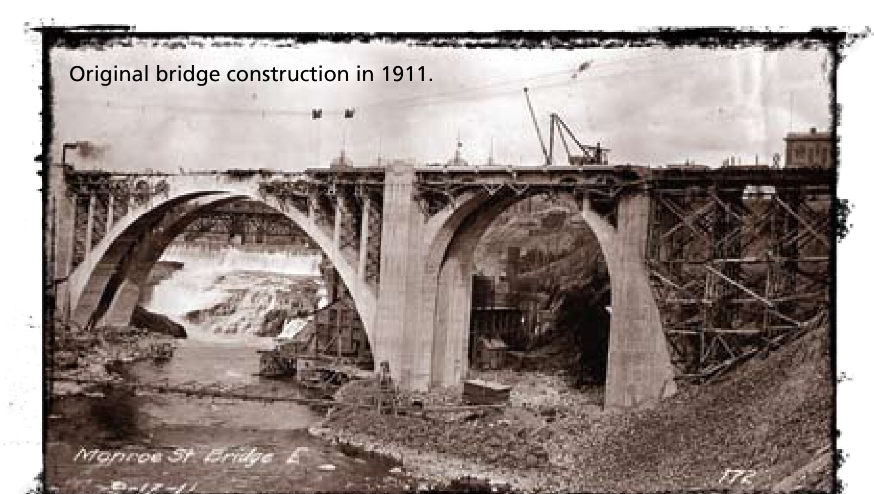
Self-Consolidating Concrete

Self-consolidating concrete was used in the intricate formwork to assist in creating smooth surfaces and substantially reducing voids. The rail components, which varied in length from 16 to 18 ft, were plant cast and stored for delivery to the construction site as each particular piece was required. Cast-in-place posts joined the railing segments to provide the final historical match.

The project included a spectacular overlook of the bridge and Spokane Falls, because of federal funding requirements for historical project-impact mitigation. Alcoves were provided along the walk. Historical information displays attached to the alcoves emphasize the historical nature of the area. Precast concrete railings, using essentially the same design and construction process as those on the bridge, formed the most visible part of this project element. The overlook railing visually tied this observation area to the bridge and helped convey the massive, solid nature of the concrete bridge construction.

The innovative design for the cast-in-place high performance concrete deck, which included a state-of-the-art silica fume mix, led to funding and testing/monitoring participation by federal agencies. Funding for the deck system was secured under the Innovative Bridge Research and Construction program, administered by the Federal Highway Administration. Ongoing monitoring and testing will be performed until January 2008.

Precast concrete panels were used to replace the existing sub-deck.



Original bridge construction in 1911.

Four precast concrete pavilions were created above the piers, replicating the design of the original pieces but located entirely on the pedestrian walkway and out of the roadway. The pavilions have interior lighting to provide additional safety for pedestrians and visual interest from afar.

Rehabilitating the bridge was made more challenging because there were no detailed plans available, and component dimensions had to be verified in the field. In several areas, poor quality concrete and little reinforcement required more demolition and reconstruction than originally anticipated. Even so, the combination of good engineering planning and close cooperation with well-qualified contractors and subcontractors resulted in a project that cost only $13.3 million, which was $2 million below the original estimate. The construction period was only slightly longer than the anticipated 2½-year schedule. The new bridge opened to traffic in September 2005 to great fanfare, with a 3-day city celebration that ended with a spectacular fireworks display.

The Monroe Street rehabilitation project is now viewed by the agencies and the citizens alike as a resounding success, and an example that others can follow for rehabilitating older, historical structures. The project approach assured that this National Historic Landmark will remain a key part of the city's transportation system as well as a historical and scenic focal point for citizens and visitors alike.

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For more information on this or other projects, visit www.aspirebridge.org.