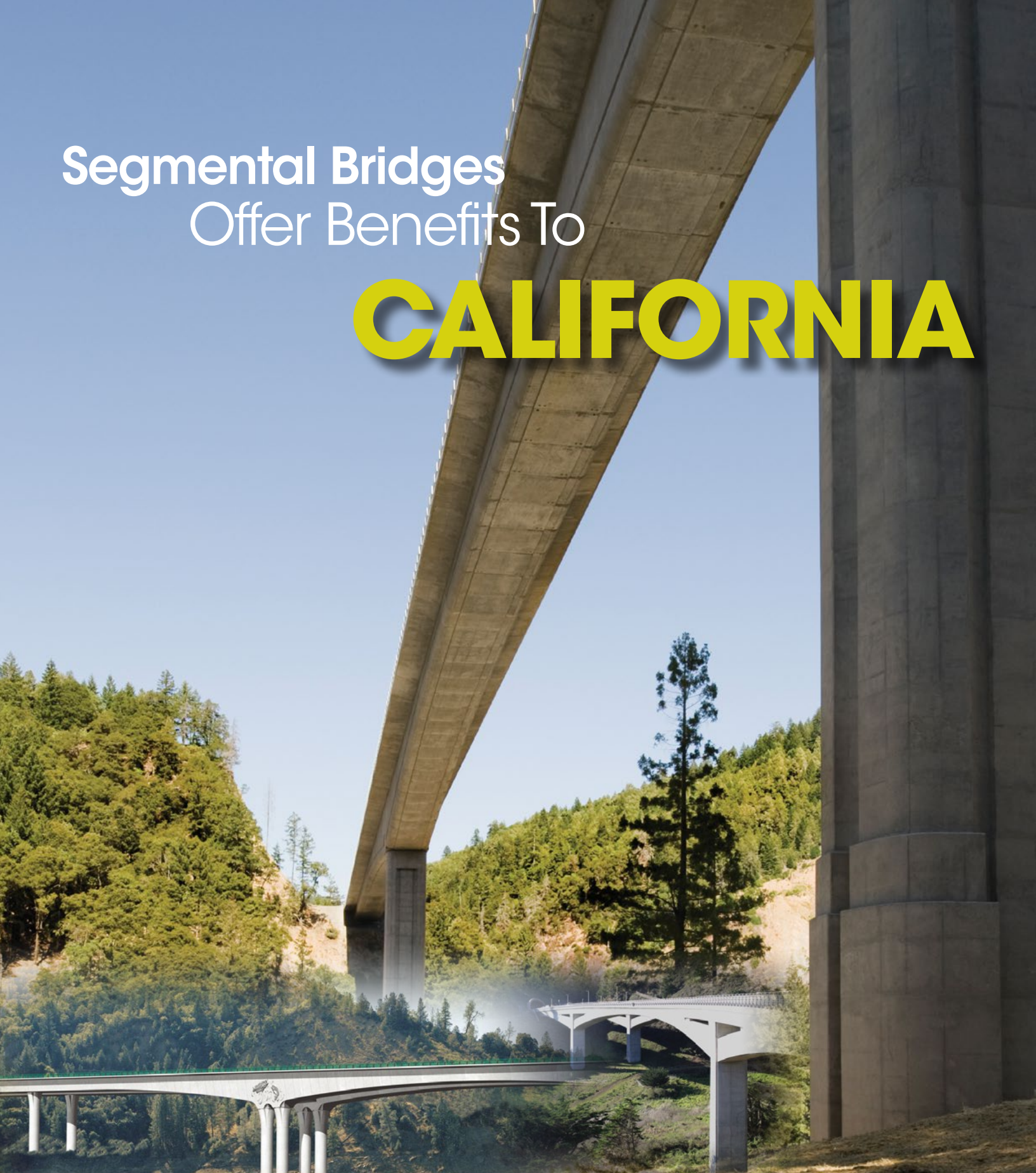


Segmental Bridges
Offer Benefits To

CALIFORNIA





Durability has become a key issue for state bridge officials as they determine the best design solutions for each unique situation. In California, segmental concrete bridge designs are used in a variety of situations that play to their strengths and offer high durability, according to Barton Newton, State Bridge Engineer for CALTRANS (California Department of Transportation). The state also is looking for new ideas to enhance durability in all their bridges.

Durability of Segmental Design

"Durability is dependent on four primary factors: the environmental conditions where the bridge is located, the design of the bridge, the materials used and how the bridge is constructed," he explains. "We take all four into account and try to maximize the design's benefits for the specific situation."

The state aims for a 75-year design life, except on a few "signature" or pivotal structures, such as the Skyway and Self-Anchored Suspension portions of the new Bay Bridge, where a 150-year life is the aim. "If we inspect our bridges regularly, they should easily obtain a 75-year service life and beyond."

But he doesn't see expanding standard service life beyond that. "Our transportation network almost certainly will be different in 100 years," he points out, noting how much has changed in the past 100 years. "Trying to design for those changes now is difficult."

Three Key Benefits

Segmental bridges are used especially in three situations, he notes. "Longer-span capability is probably the biggest benefit of a segmental concrete design. We have used segmental bridges in the 300- to 600-foot range, reducing pier requirements, saving material and lowering environmental impact."

They also provide benefits when the design can make use of the ability of precast or cast-in-place concrete segments that can be replicated with the same forms, lowering costs. "Especially when these uniform segments can be used on long-length structures, segmental bridges become very viable."

The third benefit comes when falsework would be restricted, such as around railroad yards, above other obstructions or over larger waterways. "The modular system and innovative construction methods, such as the use of an overhead gantry or form travelers, have made these designs very helpful."

The state's most recent segmental bridge is the **I-5 Antlers Bridge** over the Sacramento River in Shasta County. To be



I-5 Antlers Bridge.

Photo courtesy of CALTRANS.

Cover Photos:
(Background)

Confusion Hill South Bridge.
Photo courtesy of CALTRANS.

(Left Inset)

I-5 Antlers Bridge.

Photo courtesy of CALTRANS.

(Right Inset)

Devil's Slide Bridges.

Photo courtesy of Disney Construction Co.



Devil's Slide Bridges.

Photo courtesy of CALTRANS.

completed in 2014, it features a segmental cast-in-place design built with the balanced cantilever method using a form traveler. Other recent projects include the **Confusion Hill Bridges** in Leggett, California, a segmental cast-in-place concrete design, and the **Devil's Slide Bridges** in Pacifica, California, twin cast-in-place concrete segmental box-girder structures.

Eliminating Crack Potential

One of the key benefits provided by segmental bridges is their use of longitudinal and transverse post-tensioning in combination with high-quality, low-permeable concrete. "Post-tensioning the segments provides significant control over deck cracking. By reducing the potential for cracks, the bridge is less exposed to chloride permeability and salt degradation that can corrode reinforcement. That creates a longer life."

Due to the minimized concern for cracks, reinforcement specifications are less critical. Even so, the state uses epoxy-coated steel reinforcement in its adverse environmental zones. "We haven't seen significant benefits being derived from different types of reinforcement in segmental bridges due to the control we have in minimizing cracking. In areas where salting is done, corrosion resistance is given particular attention, through upgraded reinforcement and low-permeable concrete."

Expansion joints are a key concern. "Bridge engineers are always looking to eliminate joints—the fewer, the better." Reducing joints also helps meet California's high seismic-zone needs, he points out. "We haven't seen any problems with joints in cast-in-place concrete segmental bridges, no doubt due to the designs and attention we pay to constructability."

Those techniques include stringent geometry control. "We have more stringent controls on our segmental designs," he explains. "Combine that with the tight segment fit up, resulting from post-tensioning, helps achieve long-term durability."

Sophisticated form travelers and other erection methods have taken great strides to make these construction methods easier, he adds. "We give a lot of attention to deflection and camber control. We find that if the bridge is constructed properly there are few, or no, issues such as leakage or surface offsets with joints on segmental bridges."

State designers aim for durability redundancy, he notes. "Using epoxy-coated rebar and low-permeable concrete, and then adding transverse post-tensioning, provides us with three angles of attack. Redundancy is a good thing to a bridge engineer."

Grouting issues, likewise, have not arisen, and Newton gives credit to local contractors' expertise. "In California, we have a good roster of well-qualified contractors with good knowledge of grouting options. We also maintain a high level of oversight in the field with inspectors well-trained in grouting techniques."



Confusion Hill South Bridge.

Photo courtesy of CALTRANS.

Encourage Interaction

A key benefit of segmental concrete bridges comes by way of their sophisticated designs. "In typical design-bid-build projects, there is less interaction between the designer and the contractor during construction," he explains. "Segmental bridges often result from the newer methods of project delivery, such as design-build, or the general contractor as construction manager."

Those methods allow more interaction between the designer and the contractor, ensuring issues are resolved efficiently and creatively. "They don't always agree, but they address problems and find solutions early, resulting in a much better structure."

Finding the most effective design doesn't resolve all the issues, he stresses. "Segmental designs are good choices in many cases, but attention needs to be given to providing a high quality of construction. The contractor has to pay close attention to what they are doing and work closely with the designer to resolve issues."

New Techniques Investigated

Although the state is satisfied with its approaches to durability, it's not done looking for improvements. "Business as usual isn't enough," he says. In fact, the state is in the process of adopting new grouting specifications based on two pilot projects being run. "We want to see how they work and keep industry groups updated on what we're finding."

Among the techniques being tested are additional venting, pre-packaged thixotropic grouts for better flowability and pressure-testing in advance of grouting. They also are considering adopting standards developed by the **American Segmental Bridge Institute** and the **Post-Tensioning Institute**.

"We want to test different techniques to ensure we are always reaching for the state-of-the-art. Our goal is to ensure owners get what they pay for—and by the owners, I mean the public. **They are the real owners.**"



Confusion Hill North Bridge.
Photo courtesy of CALTRANS.

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