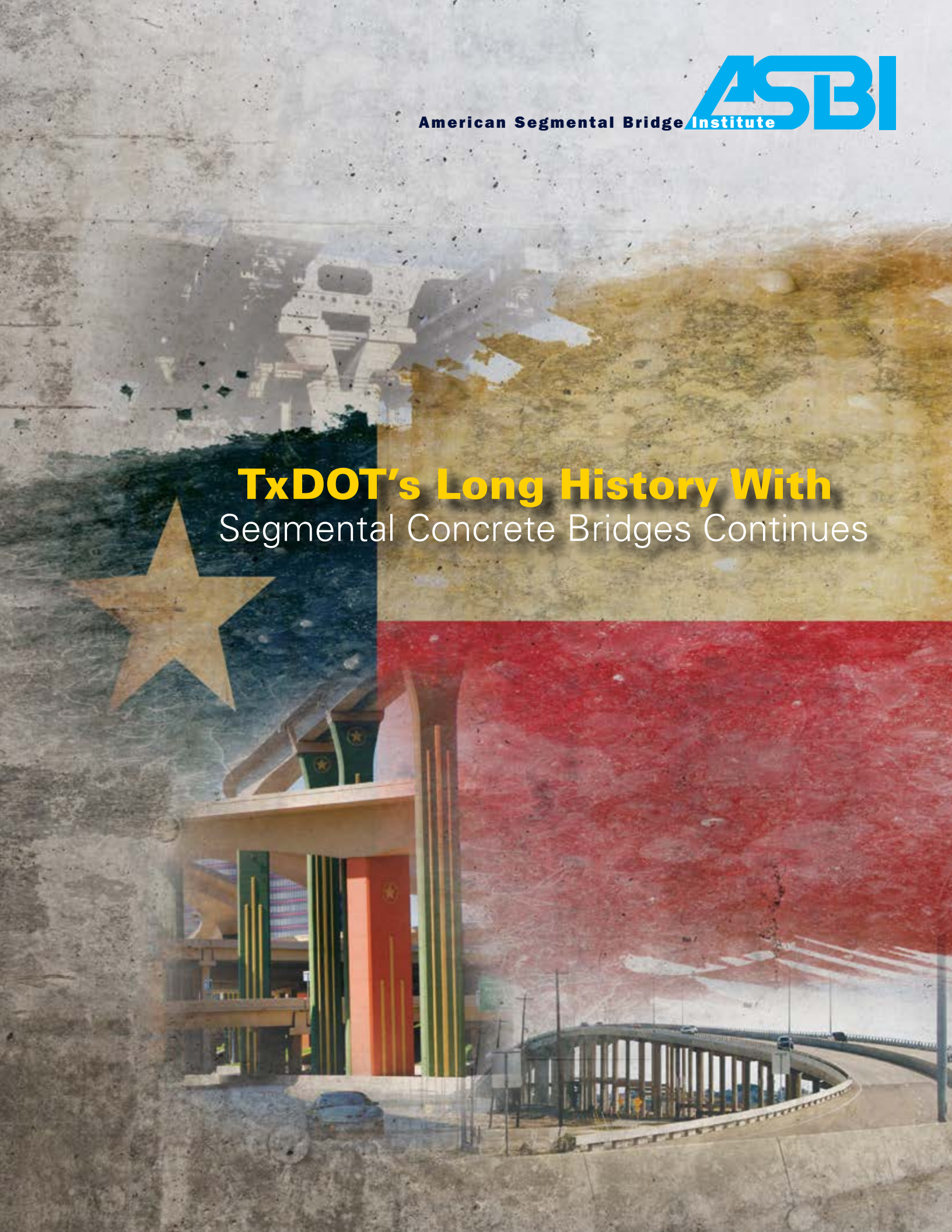


TxDOT's Long History With
Segmental Concrete Bridges Continues





Gregg Freeby
State Bridge Engineer,
Texas Department of Transportation (TxDOT)

Through the past four decades, the Texas Department of Transportation (TxDOT) has relied on segmental concrete bridge technology to resolve a variety of key design and construction challenges. Those began in the early 1970s with the construction of the John F. Kennedy Causeway over the Gulf Intracoastal Waterway, near Corpus Christi. This causeway included the first precast concrete segmental bridge in the United States. Ironically, TxDOT continues today with plans for replacing another Corpus Christi bridge with a taller precast concrete segmental bridge to provide more clearance.

Construction of the JFK Causeway over the Gulf Intracoastal Waterway, near Corpus Christi in the early 1970's.

Many of the state's segmental bridges are constructed in marine environments, where the high durability of segmental construction provides a guaranteed long life. "We believe segmental designs offer a more durable option, especially in marine environments," says Gregg Freeby, State Bridge Engineer. "It's our preference over steel plate girders in that particular environment."

That first segmental bridge was designed to provide several benefits. "We wanted the long spans it could offer, but we also liked the increased durability it could provide. The other option was a steel bridge, and we knew we'd get better durability in that environment from a concrete bridge."

The design resulted from research conducted in the 1960s that identified a need for a viable concrete alternate for spans in the 130- to 350-ft range, he explains. In the early 1970s, the department searched for a suitable project and landed on the JFK Causeway. Today, the state has 13 segmental bridges in service, with another under construction and three more under development.

JFK Causeway today.
Photo ©TxDOT.

- Cover:
- US 183 Bridge in Austin.
Photo ©TxDOT.
 - High Five Interchange in Dallas.
Photo courtesy of Mark Davis.
 - JFK Causeway over the Gulf Intracoastal Waterway, near Corpus Christi.





High Five Interchange in Dallas. Photo courtesy of Mark Davis.

Many Benefits Accrue

Segmental bridges provide a variety of benefits, Freeby says. Their range of span lengths makes them a good choice for urban viaducts, interchange structures with multiple direct-connector ramps, and for major navigation or river crossings. They also produce a durable final product, thanks to the use of precasting techniques in the controlled environment of a precasting yard. This approach also minimizes traffic disruptions during construction. If there is insufficient scale to rationalize the cost of precast segmental, TxDOT is not hesitant to specify cast-in-place segmental when needed.

“Durability often is a challenging attribute to provide, especially in coastal regions, where many of our segmental bridges are located,” he says. “But we also use them in urban areas for complex interchanges. Those choices aren’t always driven by the need for high durability, but we’re not hesitant to use a segmental design, because we know we will get good durability in addition to other attributes.”

An example is the High Five Interchange in Dallas. Completed in 2005, the interchange connects IH 635 and US 75 and serves as one of the busiest in the country. The project, at \$261-million, was the largest single project in TxDOT history at the time. It rebuilt the interchange, involving five levels of structures with five direct connectors using multispan precast segmental bridges. Span lengths up to 300 ft required variable-depth cross-sections and unique precast forming equipment to handle the needs and the sloping webs used in the cross sections.

“Segmental designs work well in urban settings, because they can reduce traffic congestion and permit reopening the bridge quickly,” he says. “With the balanced-cantilever method, they can erect a portion of the bridge from above and reopen the lower roadway that evening to traffic in the other lanes.” “For shorter segmental spans on urban viaducts, erection trusses can also quickly construct full superstructures.”

Competitive bidding also helps segmental designs win out. “Lowered costs come from the contractors who

work well with segmental designs and are comfortable with their construction,” he says. An example is the Lake Marble Falls Bridge in the Highland Lakes chain northwest of Austin. “On that project, the contractor was happy to build a segmental bridge. He had a form traveler that had been used on a previous project that he could reuse. That helped him keep his bid cost-competitive.”

Completed in 2014, the bridge features twin cast-in-place concrete balanced cantilever segmental bridges with 270-, 410- and 270-ft spans. It replaced a steel truss bridge that had a primary variable-depth unit with spans of 230, 276 and 230 ft and a constant-depth unit with two spans of 78.25 ft. “The new variable-depth concrete structure and long-span lengths give a similar form as the previous truss bridge that had been a fixture of the community for so many years,” he explains.

No Performance Issues

For segmental bridges, TxDOT has fewer concerns about deck longevity than many states because they seldom use deicing chemicals. “We get most of our segmental bridge deck durability from precompression in post tensioning the deck transversely and longitudinally in negative moment areas,” he says.

For that reason and others, the state typically uses uncoated reinforcement for most bridges. “We are open to using epoxy-coated reinforcement if there is a compelling need, and we’ve even allowed contractors to use glass fiber-reinforced polymer reinforcement in place of epoxy-coated reinforcement if they want. With segmental designs, we’re always receptive to new types of reinforcement.” For segmental designs, TxDOT hasn’t used stainless steel reinforcement, even in marine applications. “We get so much deck compression by post-tensioning the components that we haven’t had a need to supplement it.” TxDOT, however, has specified stainless steel reinforcement in specific areas of conventionally reinforced concrete substructures in marine environments.



Lake Marble Falls Bridge in the Highland Lakes chain northwest of Austin. Photo ©TxDOT.



US 183 Bridge in Austin. Photo ©TxDOT.



Photo ©TxDOT, Chris Bishop.

Expansion joints can present challenges, but TxDOT has had no issues with them. “We’re always trying to push the envelope on eliminating expansion joints in all types of structures. We’re pushing out to the 300- to 350-ft range with spans more often in part to eliminate expansion joints. But we rarely run into issues with them.”

The US 183 Bridge in Austin, for instance, is a simple-span segmental bridge with finger joints. “We’ve had good experiences with standard finger joints. We’ve used modular joints on long spans and finger joints on shorter ones with no issues. We don’t have any restrictions on how they can be designed.”

TxDOT is a strong supporter of epoxied joints for precast segmental construction, he notes, “A post-tensioned epoxy joint will be solid, without any leaking.” The state also uses low-permeable concrete whenever possible. “Any time we think deck durability may be an issue, we use high-performance concrete, mostly for lower permeability rather than strength in coastal areas or areas where we use deicing agents.”

Durability also is aided by the use of additional cover on the deck surface. This is mostly used to allow contractors a final grinding if they require it to achieve a comfortable riding surface. “We leave that up to the contractor and the workmanship being used on the project.”

Relying on the contractor was a key element in the design for the Corpus Christi Harbor Bridge now underway. The bridge is one of the first segmental bridges produced under a design-build contract and, reportedly, will be the longest concrete cable-stayed bridge in the United States when completed. The bridge will be constructed with precast concrete segments with a main span of 1,661 ft. The design will provide greater access for ships delivering cargo to the harbor and includes a maintenance agreement that covers design, construction, finance, and 25 years of maintenance support.

Such maintenance agreements help TxDOT achieve its goal of creating 100-year service lives for its bridges. Freeby says its segmental bridges probably achieved that goal from the start. He points to that first project in 1973, which shows few signs of wear to date. “The JFK Causeway is performing great, and there’s been no talk of replacing it. I expect it will easily last another 50 years.”

More to the point, he says, current designs will achieve 100-year service lives unless funding and mindsets change dramatically. “If you look at budgets and the rate of replacement we’re seeing now, new bridges that we’re building are going to last 100 years whether we intend them to or not,” he says. “There won’t be the money or desire to replace them sooner. That reality gives us an incentive to find ways to ensure they will last that long. And we don’t hesitate to select a segmental concrete design to meet that need.”



Corpus Christi Harbor Bridge. Rendering courtesy of FIGG.

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