Texas

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Everybody knows that Texans like to brag about big numbers, and the state's bridge inventory is no exception: With over 55,000 state and locally owned structures, Texas has the largest inventory in the United States. But Texans take even greater pride in a small number: 1.3%. That is the current percentage of poor-condition bridges in the state, compared to a national average of 7.5%.

The condition of Texas' bridges was not always so well ranked. In 2001, 6.6% of all bridges in Texas were rated as structurally deficient, as were 14.8% of locally owned (off-system) bridges in the state. (**Fig. 1**). To reduce those numbers, the Texas Department of Transportation (TxDOT) developed a deliberate and calculated plan. All poor-condition ("structurally deficient" is no longer a term used in the National Bridge Inventory) bridges in the state, not just the state-owned (on-system) structures, were identified, and a prioritized list for rehabilitation and replacement was generated. TxDOT did not focus solely on bridges owned and maintained by the state because the top priority was (and is) the safety of the traveling public.

Leveraging the Benefits of Precast Concrete

As a government agency, TxDOT has a responsibility to be a good steward of the tax dollars it receives. Concrete and, in particular, precast concrete have played a major role in drastically reducing the percentage of poor-condition bridges over the past two decades.

TxDOT engineers enjoy big, complex, signature structures as much as anyone, but the bulk of the department's bridge work involves building structures with essentially the same puzzle pieces over and over again. Those puzzle pieces are made up primarily of precast concrete.

When it comes to options for precast concrete, TxDOT's catalog includes a wide range of standard shapes and designs. TxDOT builds, on average, about 350 new bridges a year. That includes roughly 250 bridges to replace other structures, most of them rated as poor condition. Roughly 95% of span-type bridges (nonculvert structures) are designed and constructed with prestressed concrete superstructures. In addition to bulb tees (typically called Tx girders), TxDOT precast concrete standard drawings include options for slab beams, box beams (adjacent or spread), U-beams, and decked slab beams. In recent years, TxDOT has expanded its use of spliced precast concrete girders to construct spans up to several hundred feet in length, using a combination of pretensioning and post-tensioning.

TxDOT also has standard drawings for other precast concrete components such as abutment caps, bents, piling, and MASH-compliant railing. The decks on almost all prestressed concrete bridges are constructed using stay-in-place prestressed concrete subdeck panels. Standard drawings for precast concrete columns are currently being developed, and once those are in place, TxDOT will routinely be designing bridges from the ground up using essentially 100% precast concrete elements.

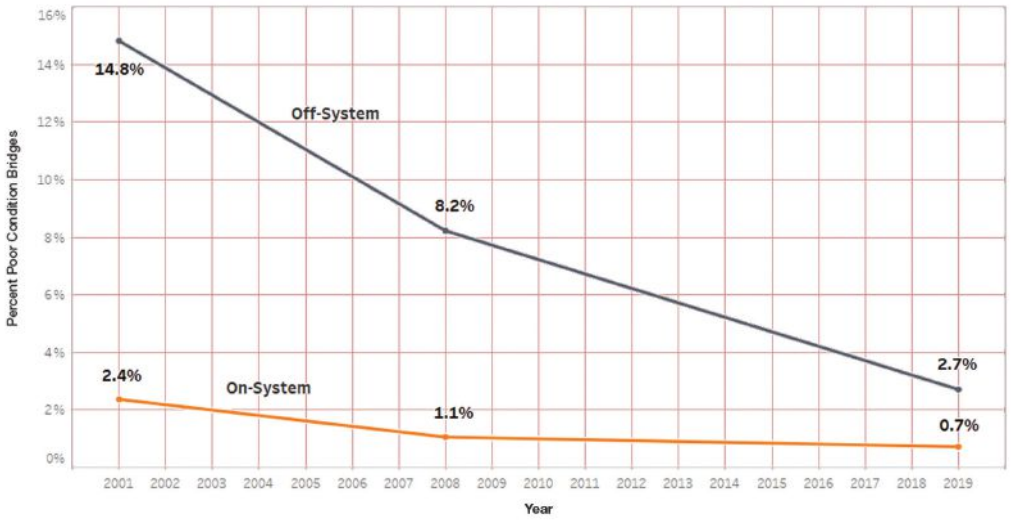
Increasingly, TxDOT has found that using precast concrete standards allows contractors to build new bridges at such low prices that it can be more cost effective to replace existing bridges instead of rehabilitating them. Texas routinely has some of the lowest unit-rate construction costs for new bridges in the United States. That allows the state to stretch the available dollars and maximize the number of poor-condition bridges it can replace.

Partnering with Local Owners

For state-owned structures, prioritizing replacement of poor-condition bridges has been straightforward. TxDOT simply made rehabilitating or replacing them a priority and went about it.

The bigger challenge has been addressing the poor condition of locally owned bridges because many counties and cities face funding

Figure 1. Percentage of poor-condition bridges in Texas, 2001–2019. Figure: Texas Department of Transportation Bridge Division.



challenges when it comes to infrastructure maintenance. Currently, locally owned bridge replacement projects are usually funded by 80% federal, 10% state, and 10% local government funds. However, the State of Texas developed a process that gives local governments two options: the locality can pay its 10% portion for a bridge replacement or the State will cover the local portion if the local government can demonstrate a 10% match spent on bridge maintenance activities elsewhere in its jurisdiction.

The latter arrangements, which are referred to as participation-waived projects, are carried out via the Equivalent Match Project (EMP) Program. Local agencies can use their 10% match on other bridges to improve structural capacity, improve hydraulics (including low-water crossings), increase bridge roadway width, or provide adequate bridge railing and approach guardrails. This program is highly beneficial for everyone. Local governments can stretch their infrastructure funding and have greater incentive to perform proactive maintenance activities on their bridges. Additionally, the EMP Program allows TxDOT to make progress on its goal of reducing the number of poor-condition bridges in the state. Most importantly, the EMP Program improves the safety of Texas roadways for the traveling public.

Ten of the fifteen spans of the RM 2900 Lake Lyndon B. Johnson Bridge at Kingsland, Tex., were washed out during an October 2018 flooding event. A replacement bridge comprised of prestressed concrete standard Tx34 bulb-tee girders and other standard components including partial-depth precast concrete panels, elastomeric bearing pads, and railings, allowed the bridge to be opened in May 2019. Photos: Texas Department of Transportation Austin District.

Relying on Standards

In addition to working with local governments, TxDOT collaborates frequently with contractors and precast concrete fabricators to ensure continual improvement of methods. The message from contractors has been clear: Keep bridge construction simple, and keep it repetitive. That is a mantra that TxDOT has also adopted. It applies not only to standard bridge construction but also to emergency projects. Texas has more than the usual share of overheight vehicle impacts, barge impacts along the coast, and flash flooding that can cause extensive damage to bridges and their approaches. Unique accelerated bridge construction techniques such as slide-in or self-propelled modular transporter moves are great when the construction team has time for a lot of advanced planning and preparation—but not when responding to emergencies. With that in mind, TxDOT designers typically stick with standards when a bridge must be rapidly replaced due to an emergency. Two recent examples of that approach are highlighted here.

Damaged main span of eastbound Interstate 10 over State Highway 304 at Gonzales, Tex., after an overheight vehicle collided with it. Photo: Texas Department of Transportation Yoakum District.

RM 2900 Lake Lyndon B. Johnson Bridge

In October 2018, a historic flood caused the typically docile Lake Lyndon B. Johnson to become a raging river. Consequently, ten of the fifteen spans of the 1200-ft-long RM 2900 Bridge over the lake were completely washed out when the rising water inundated the beams and deck.

Fortunately, TxDOT personnel recognized the hazards associated with the rising water and closed the bridge before it washed out. But the closure required a 45-minute detour in a bustling community (Kingsland is a popular retirement and recreation area northwest of Austin). Therefore, it was critical that the replacement bridge be designed and constructed as quickly as possible.

Considerations for span length, superstructure type and depth, substructure type, hydraulic performance, design simplicity, construction economy, and total construction duration made a prestressed concrete bulb-tee bridge the logical choice. The plans developed for this project included the following specific features and improvements:

The replacement of the damaged span of eastbound Interstate 10 was completed in 11 days. The Texas Department of Transportation opted to replace the entire span rather than repair or replace only the damaged section. Photo: Texas Department of Transportation Yoakum District.

- Whereas the original structure had 40-in.-deep beams, the new bridge used shallower 34-in.-deep beams with 80-ft spans with bents placed to avoid existing foundations and debris. Two of the fifteen spans were offset by 15 ft to avoid original bent locations.
- The replacement bridge has drilled-shaft foundations with permanent casings and extensions into hard granite layers that the original multiple steel H-pile foundations did not have. Extending the foundations into the granite took significant effort and time, but it was judged to be critical to prevent future washouts if similar flooding occurs.
- The replacement structure has modern TxDOT partial-depth precast concrete subdeck panels.
- Options for precast concrete bent caps and precast concrete deck overhangs helped expedite construction.

By using precast concrete standards, TxDOT engineers were able to complete the design in a matter of days. TxDOT has an emergency certification process that allows plan development and letting to occur in an expedited fashion for emergencies like this. Many different disciplines within TxDOT contributed to advance the project from the onset of the event to 100% plans and emergency letting within two weeks of the washout.

Even with challenges posed by removing the extensive debris (including the washed-out bridge) and by extending the foundations into the solid granite base, the bridge was opened to traffic only seven months after the washout occurred. The expediency of this project can be directly associated with the use of TxDOT precast concrete design and construction techniques.

Interstate 10 over State Highway 304 Span Replacement

Because large vehicles are necessary to support the Texas energy and heavy construction industries, overheight vehicle impacts to Texas bridges are a frequent occurrence. In April 2020, the eastbound Interstate 10 bridge over State Highway 304 near Gonzales, a town between San Antonio and Houston, sustained significant damage when a vehicle transporting a large pressure vessel struck the middle span.

Two options were considered to address the damage. One proposal was to saw cut the deck and repair and replace the damaged beams within the span while maintaining one lane of traffic. The alternative plan was to temporarily move traffic onto the frontage road and completely replace the damaged span.

It did not take much time for TxDOT to conclude that complete span replacement was the preferable option. The contractor could perform the work more quickly, and construction and inspection personnel would not have to work immediately adjacent to traffic.

Within one week of the event, plans were completely developed and let to contract using TxDOT's emergency certification and letting process. The precast concrete industry responded by prioritizing production and having replacement girders ready within one week of contract award. The single open lane on the eastbound bridge was closed to allow the contractor to perform demolition and span replacement. By expediting the construction process while using almost entirely standard bridge elements (girders, deck, and railing), the span demolition and replacement were completed in only 11 days, and traffic was fully restored within one month of the collision.

Looking to the Future

TxDOT looks forward to finding ways to keep its percentage of poor-condition bridges at or near the lowest in the country, both for state and locally owned structures. At the same time, TxDOT will continue developing new standards that allow bridges to be constructed quickly, at low cost, and with long service life. Precast concrete is a huge part of both those initiatives. TxDOT has relied on precast concrete for over 60 years, and will continue to do so for new bridges, replacement bridges, and emergency response. TxDOT welcomes the opportunity to collaborate with owners, contractors, and fabricators from around the country to further refine the state's already extensive use of precast concrete in all facets of bridge design and construction.

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