Concrete Bridges in

Arizona

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Loop 202 over Indian Bend Wash, Tempe. (Seven-span prestressed concrete I-girders). All photos: Arizona Department of Transportation.

Historically, concrete has been the material of choice for bridge construction in Arizona. Raw materials needed to produce concrete are readily available within the state. Prestressed I-girder and post-tensioned box girder bridges have been the most commonly constructed bridge types on Arizona's highways for the past several decades, especially in urban settings. Examples of early precast I-girder bridges dating to the 1950s can still be found throughout the state. Over time, Arizona bridge construction has followed the industry trends to use larger precast, prestressed I-girder shapes that can span longer distances, thus eliminating costly substructure units and providing plausible solutions to complex bridge sites.

Historical Overview

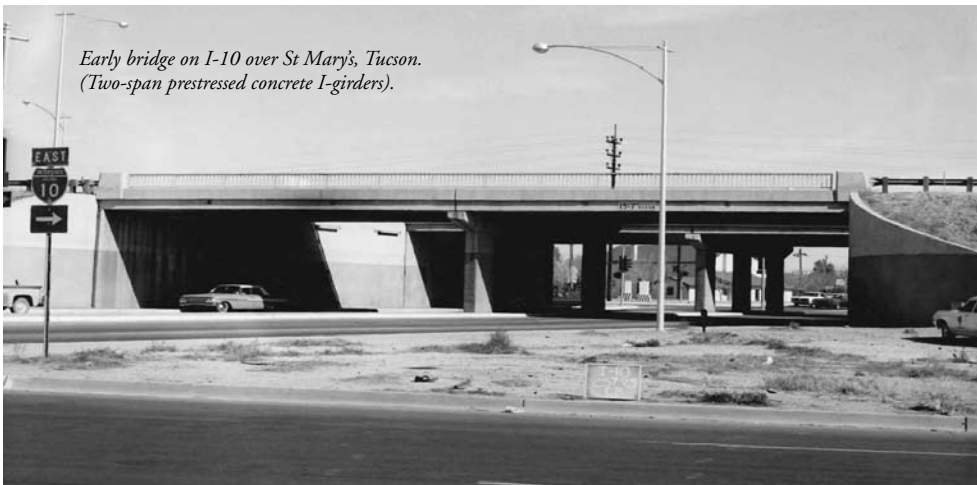
The use of precast concrete girders began in Arizona in the late 1950s. Precast girders of various types can be found on all of Arizona's interstate and state highway routes. The earlier types of precast girders consisted of small I-girder shapes, voided slabs, and box beams. The AASHTO Type II girder appears to be the primary precast girder used in many bridges in the original construction of I-10 and I-17 in the Phoenix and Tucson areas. For economical reasons, similar span and girder arrangements were used as frequently as possible. Voided slabs and box beams with asphaltic concrete overlays were used on the I-40 and various state highways. Construction plans for these girders often allowed the contractor a choice between prestressing methods: either pretensioned or post-tensioned. In most instances, as-built drawings did not document which method was used. High profile vehicle collisions with such girders, exposing ducts or strands, offered some clues to the mystery.

Early bridge over I-17, Central Phoenix. (Two-span prestressed concrete I-girders).

Current Practice

Today, the more commonly used precast girders are those that can span 90 to 135 ft, such as the AASHTO Type IV, V, and VI girders.

Loop 202 and Interstate 10 Interchange, Chandler. (Post-tensioned box girders).



Early bridge on I-10 over St Mary's, Tucson. (Two-span prestressed concrete I-girders).

Arizona uses modified versions of the Type V and VI for most bridges. The modified girder type has flange and web widths that are 2 in. narrower than the regular type to reduce the amount of dead load transferred to the substructure. Type II and III girders are no longer being used on new bridge construction due to their span limitations. Their use has declined so much that Arizona fabricators no longer have the formwork to make them. Recently, a contractor replacing a Type II girder damaged by a high vehicle collision had to use an Idaho supplier.

Damage assessment at Tangerine over I-10, Tucson. (Two-span prestressed concrete I-girders).

Another modified girder type used in the past and in several recent projects is what we term a Super Type VI girder. The depth of the AASHTO Type VI girder is increased by 6 in. The Super Type VI girder was first used on the mile long Salt River Bridge carrying the Loop 202 freeway within the city of Tempe. The eastbound and westbound bridges consist of 34 spans with one span of Type V girders, eight spans of standard Type VI girders and 23 spans of the Super Type VI girders.

Loop 202 over Alma School, Mesa. (Two-span prestressed concrete I-girders).

Collision Damage

The strength and resilience of precast concrete girders have been tested on many occasions when girders have been damaged by over-height vehicles. In most cases, the damaged girders have been easily repaired with epoxy injection and high strength grout patching. Only in few instances were the whole girders replaced.

Phoenix metropolitan area. (Relief on exterior girder).

Expansion of the Urban Freeway System

During the last two decades, the Arizona Department of Transportation (ADOT) has been faced with the challenge of expanding the freeway system to accommodate the increased volume of traffic generated by the growing urban metropolises of Phoenix and Tucson. This expansion is being accomplished by widening existing freeways and the construction of additional freeways.

In the heart of Phoenix on I-17, ADOT has replaced many of the first generation AASHTO Type II girder bridges, which carry local streets over the interstate, with shallower precast, prestressed adjacent box beam bridges to accommodate longer spans and to improve vertical clearances over the interstate.

In the Tucson area, I-10 is currently being widened. Many of the bridges use AASHTO Type II girders and are being widened in kind with Type II girders shipped from out of state.

Future Outlook and Challenges

Aesthetics considerations are becoming increasingly important in the construction of transportation facilities. Bridges constitute some of the most visible elements of the transportation infrastructure. Precast, prestressed concrete bridge elements can be constructed with reliefs on the exterior girder or box elevations to enhance the visual appearance of the structure. ADOT has implemented these methods on many urban projects.

We also realize that new shapes and some innovative bridge design ideas will have to be implemented in order to meet some of the future challenges that we are facing. We are experiencing increased demand for longer spans, shorter construction durations, and reduction in construction-caused traffic delays. Use of precast member elements for bridge construction in other than the superstructure such as in column cap beams and abutments could solve some of these issues. Precast, prestressed concrete is versatile, durable, and enables shorter construction durations.

Due to a recent increase in development throughout Arizona, bridges are being proposed and funded by private developers. In order to streamline this process, ADOT has developed an on-line manual. (See *Concrete Connections* on page 52 for website address.) This includes a typical footprint for urban traffic interchange bridges that incorporates future widening criteria for both the highway and the cross street. This footprint consists of a two-span bridge with span lengths of 135 ft, which could be achieved through the use of AASHTO Type VI girders. Longer spans would be required in case of a skew to the bridge.

In the Phoenix metro area, many of the freeways that were built within the last two decades are already being widened. In many cases, these freeways were originally constructed prior to the land being developed around them. This afforded us the luxury of building on new alignments without being concerned about traffic control. Common bridge types were cast-in-place post-tensioned box girders. However, widening of these existing roadways is presenting many challenges. We are faced with a wide range of issues, which include minimizing traffic impacts during construction, constructing over traffic, maintaining minimum vertical clearances, site restrictions due to tight right-of-way, various environmental issues, and multiple requests

Wild Horse Pass over I-10, south of Phoenix. (Two-span prestressed concrete I-girders).

from the public and the affected municipalities.

Nowadays, Arizona bridge designers are looking at new solutions to conquer these challenges. A current project involving the widening of 10 miles of urban freeway, including 20 post-tensioned box girder bridges and three precast AASHTO girder bridges, is under development. Four of the box girder bridges span over single point interchanges, one with a single span of 250 ft. A combination of precast, prestressed girders; precast, post-tensioned spliced girders; and several new precast shapes such as tub girders and trapezoidal box beams are being considered. While the tub and trapezoidal box beam girder shapes have been used in other states, they have not been developed in Arizona partly due to the startup cost involved with their development.

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For more information on Arizona's bridges, visit www.azdot.gov/highways/bridge/index.asp.

Camelback over I-17, central Phoenix. (Two-span prestressed concrete I-girders).

Environmental Constraints

Arizona highways traverse a variety of terrains including flat desert, rolling hills, and deep canyons. Environmental concerns such as minimizing the impact to unique or impaired waterways, minimizing disturbances of sensitive sites, and avoiding archeological features create many construction challenges. Precast concrete elements can minimize the footprint of the bridge. For waterway crossings, precast members eliminate the need for falsework during construction. This reduces the environmental impacts and minimizes the risk posed by flash floods.

A recent project to construct a 7.5-mile-long segment of the new Route 188 connecting the city of Globe with the Roosevelt Lake recreational area northeast of Phoenix contained six precast concrete girder bridges. Some bridges were needed to provide wide open areas beneath the roadway for wildlife crossings within the Tonto National Forest and others were built to span waterways. Precast girder types ranging from AASHTO Type IV to Type VI provided the means to span the varying terrain of the new roadway alignment. The use of precast, prestressed concrete girders minimized site disturbance, eliminated the need for falsework construction in washes prone to unpredictable flooding, and reduced the construction time. This project won the ARTBA 2006 Globe Award for Environmental Excellence.

State Route 188 over Apprentice Wash, Gila County. (Three-span prestressed concrete I-girders).

Expanded Shale, Clay, and Slate Institute

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The Expanded Shale, Clay & Slate Institute (ESCSI) is the international trade association for manufacturers of expanded shale, clay, and slate (ESCS) aggregates produced using a rotary kiln. The institute is proud to sponsor *ASPIRE*™ magazine.

Lightweight aggregate concrete has been used successfully in the rehabilitation of many bridges, including such well known bridges as the Brooklyn Bridge (N.Y.), the San Francisco-Oakland Bay Bridge (Calif.), the Woodrow Wilson Bridge (D.C.), the Louis and Clark Bridge (Wash. and Ore.), the Whitehurst Freeway (D.C.), the Chesapeake Bay Bridges (Md.), the Cape Cod Canal Bridges (Mass.), and the Coleman Bridge (Va.).

Using lightweight concrete for bridge rehabilitation can provide the following benefits:

- Wider decks with little or no modification of the existing structure;
- Reduced deck weight to improve the load rating on an existing structure;
- Reduced weight of precast elements for hauling and installation; and
- Enhanced durability.

For more information on lightweight concrete, including a listing of ESCSI members and available publications, please visit www.escsi.org. The members of ESCSI look forward to assisting owners, designers, and concrete producers in using lightweight concrete for bridges.

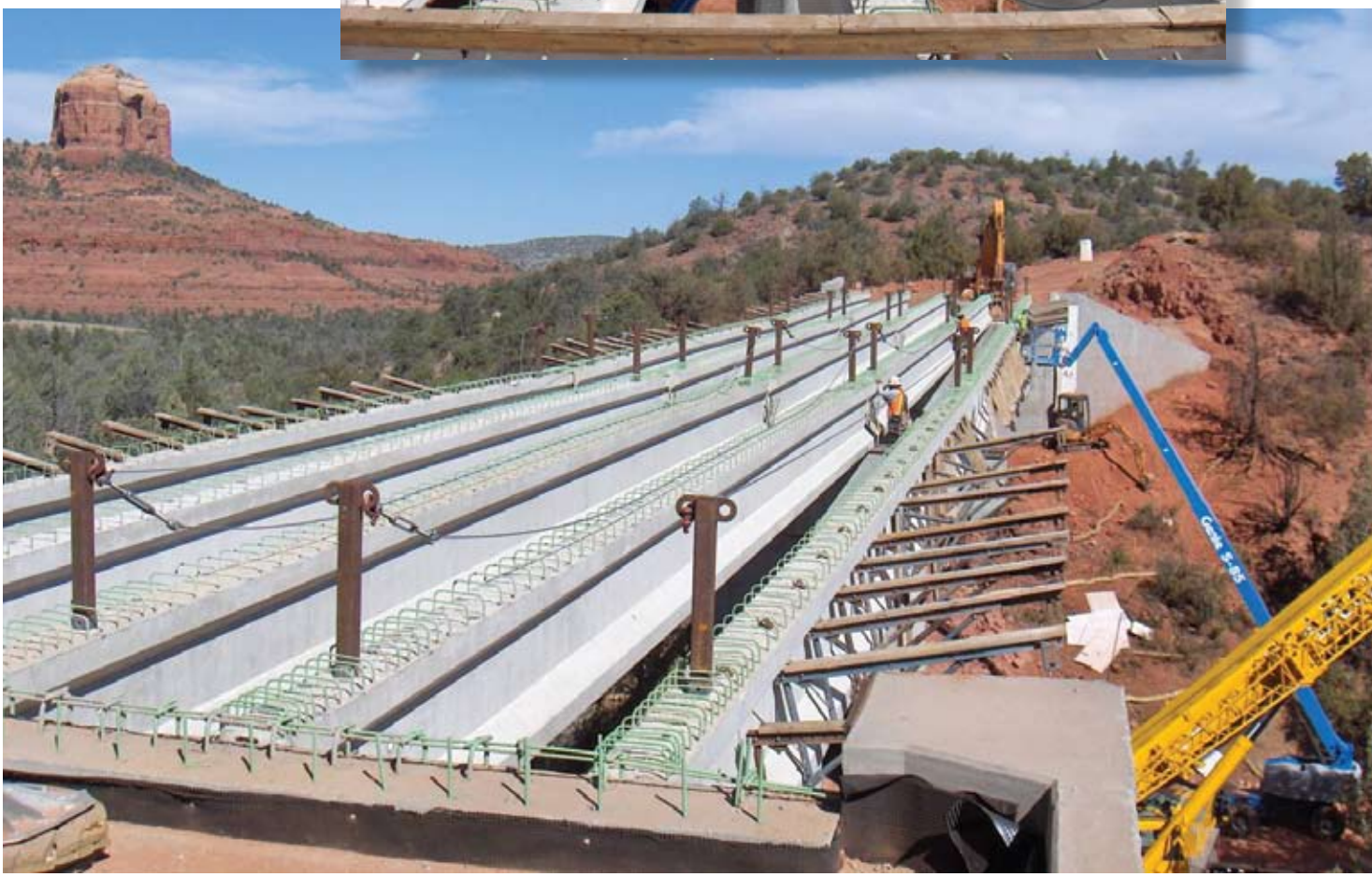
All Photos: Arizona Department of Transportation

Raintree over Loop 101, Scottsdale. (Two-span prestressed concrete I-girders)

Loop 202 over Salt River, Tempe. (39-span prestressed concrete I-girders)

State Route 260 over Preacher Canyon, Gila County. (Five-span prestressed concrete I-girders)

All Photos: Arizona Department of Transportation



State Route 179 Under Construction, south of Sedona. (Three-span prestressed concrete I-girders)

All Photos: Arizona Department of Transportation

Inset Photo:
Jefferson over I-17, Phoenix.
(Damaged two-span
prestressed concrete I-girders)

Jefferson over I-17, Phoenix. (Repaired two-span
prestressed concrete I-girders)

All Photos: Arizona Department of Transportation

I-10 HOV, Central Phoenix.

State Route 87 over Sycamore Creek, Maricopa County. (Six-span prestressed concrete I-girders)

All Photos: Arizona Department of Transportation

67th Avenue over U.S. 60, Glendale. (Six-span prestressed concrete I-girders)

Loop 101 over Chandler Blvd, Chandler. (Two-span prestressed concrete I-girders)

All Photos: Arizona Department of Transportation

Loop 202 and Interstate 10 Interchange, Chandler. (Post-tensioned box girders)

State Route 51 HOV, North Phoenix. (Under Construction)

All Photos: Arizona Department of Transportation

Superstition Springs over U.S. 60, Mesa. (Damaged two-span prestressed concrete I-girders)

Superstition Springs over U.S. 60, Mesa. (Repaired two-span prestressed concrete I-girders)