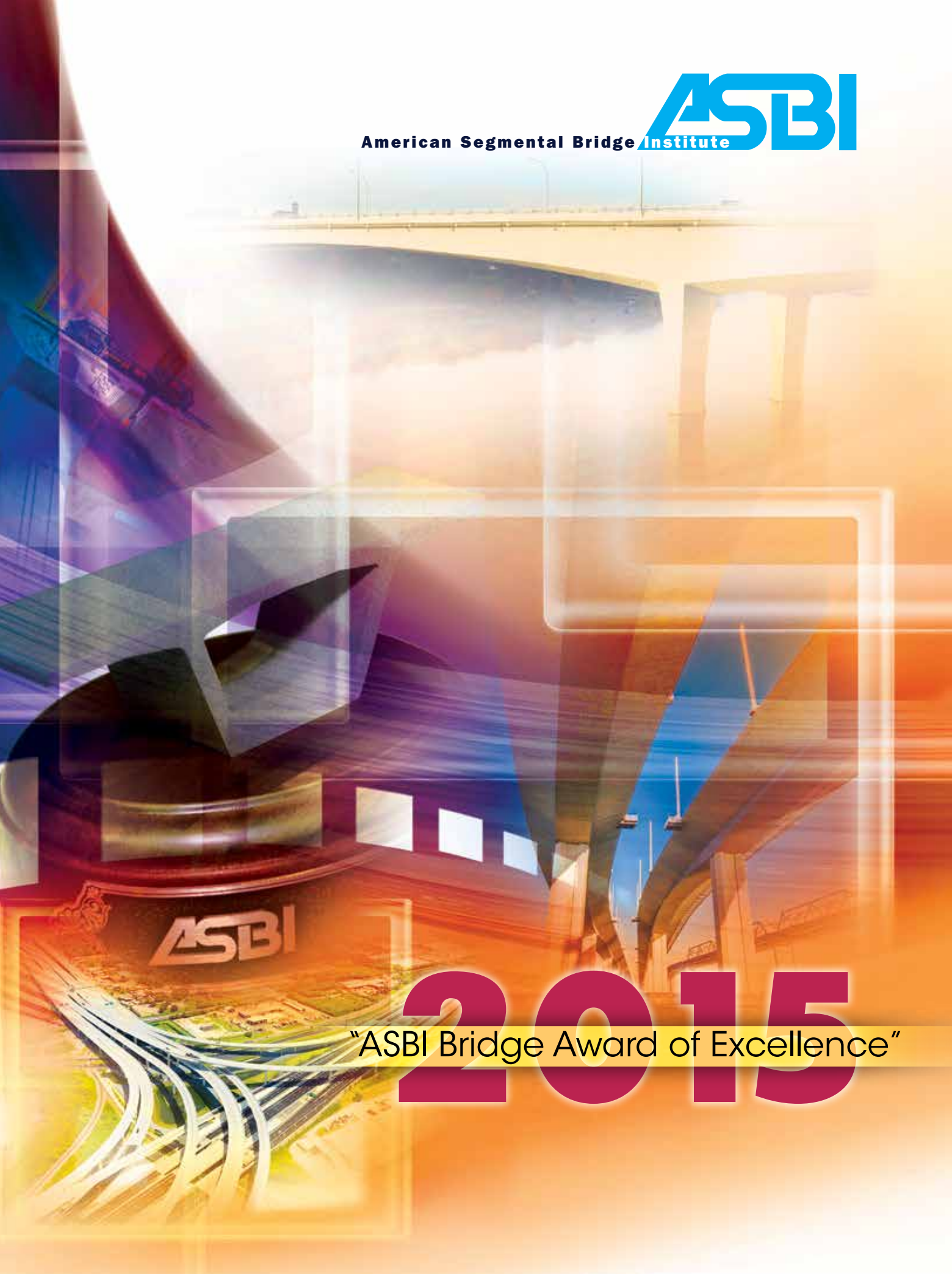
American Segmental Bridge Institute



2015

"ASBI Bridge Award of Excellence"

Section 5 Palmetto SR826/836 Interchange (Bridges 9, 11, 15, and 19)

The reconstruction of Section 5 Palmetto SR 826/836 Interchange will create safer and less congested travel for 430,000 vehicles traveling through the interchange daily.

This $559 million design-build-finance project involves the construction of an Interchange between SR 826 and SR 836, two limited access facilities, as well as the reconstruction of SR 826 at Flagler Street and SR 836 at NW 72nd Avenue interchanges. Capacity improvements include the reconstruction and widening along both SR 826 and SR 836, and the construction of 46 bridges. The project will provide new direct connector ramps for major improvements and collector-distributor ramps to eliminate existing geometric and operational deficiencies.

Four high-level precast segmental bridges traverse the core of the interchange and form the centerpiece of the intersection. These bridges are 46 feet wide and range in length from 31,100 feet to 2,450 feet. Total deck area is 360,718 square feet, with 7,764 linear feet for the segmental bridges. The longest span is 266 feet, the tallest pier is 81 feet and there are 783 total segments.

The curved segmental bridge ramps are the third level of the interchange with radii down to 590 feet and a proposed maximum superstructure deck height of 95 feet above ground. All of the bridges are supported on 24 inch pile foundations and reinforced concrete piers and caps.

Innovation of Design and/or Construction

Design innovations reduced construction costs by nearly $100 million dollars. The redesign reintroduced three points of access to the Expressway that would have been lost in the original design plan, a much-preferred option for the Florida Department of Transportation (FDOT) and the area's traveling public. **Three out of four Alternative Technical Concepts (ATCs) were accepted for segmental bridges:**

1. **FIRST USE OF DIABOLOS IN THE STATE.** FDOT allowed diabolos for the first time based on the advanced design and demonstration of their successful application on segmental bridges in other states. Traditional bent steel pipes were eliminated, segment weight was reduced allowing for variable tendon geometry and continuous external tension ducts. External tendons will reduce future maintenance costs through improved future access for tendon replacement, as well as upgrading and stressing of any single strand inside the box.
2. **HAUNCHED SEGMENTS.** Increased in span lengths reduced the amount of temporary supports adjacent to the highway and simplified the design of the interchange. Expansion joints were eliminated. This also increased the efficiency of post-tensioning and provided the capacity to support the launching gantry.
3. **POLYSTYRENE HOLLOW PIER COLUMNS.** Use of Polystyrene in the hollow pier columns cores (except for solid bases and caps) eliminated the need for interior formwork, thereby reducing the amount of concrete material and overall mass of the structure.

Other innovations:

- **PIER CAPS.** The pier caps were designed to support the balanced cantilever during construction, and include loop tendons through the caps to tie down the launching gantry and curved balanced cantilever superstructure. In addition to their vital functional role in the construction process, the pier caps contribute to the overall aesthetics, an important factor considering the prominent location of the interchange.
- **NON-TRADITIONAL SHAPED PIERS.** Using non-traditional shaped piers, adjusting the footing size to accommodate conditions, and increasing span lengths all helped improve maintenance of traffic sequencing, which was critical to accelerating the project schedule. Advance planning for building the foundation, for what would be the last segmental bridge, much earlier in the schedule was another critical aspect.

All Photos Courtesy of FDOT

Jury Comments

Great solution in a difficult urban environment. Proportioning piers caps to accept temporary jacks for cantilever stability during construction was an innovative way of eliminating temporary stability towers, reducing impacts to the motoring public. Rapid construction completed 4½ years ahead along with significant cost savings proves once again, segmental is a competitive structure type. First use of diabolos in Florida was proven successful.

Rapid Construction

The design-build team realized that the critical path depended on speed of construction of the high-level segmental bridges. Most notable and significant among these design solutions was the decision to build the four segmental bridges "from the top down."

- Use of a 460-ft. self-launching overhead gantry to build the precast segmental bridges in balanced cantilever over the core of the interchange reduced the need for temporary supports on the ground and segments that were stabilized off the pier caps.
- The casting yard was located 8 miles away from the project and transportation time of the segments ranged from 30 to 90 minutes.
- Three casting machines were utilized, one for pier and expansion segments, and two for typical segments. There were no rejected segments.
- Equipment and construction had to move fast and Quality Control was a key to keeping the project on the critical path. The engineer of record for the high-level segmental bridges understood these challenges and built the design into the construction methodology.

Aesthetics and/or Harmony with Environment

The bridge design, which included haunched segments, met a major project goal - strong aesthetic requirements. The segmental bridge design is highly-aesthetic and features mechanically stabilized earth (MSE) walls. Multi-color, Energy Star LED lighting that are mercury-free, long-lasting and economical will be added to the four high level segmental bridges to enhance the stunning architectural details at night.

Cost Competitiveness

- $332.67 per square foot.
- Segmental bridge costs: $120 million. Total deck area: 360,718 sq. ft.

Minimization of Construction Impact on the Traveling Public

The design offered unique challenges integrating underlying roadways, canals and Maintenance of Traffic (MOT) requirements into the layout of these segmental bridge ramps. Nightly road closures were implemented to allow for erection of segments (11PM – 5AM).

This project was constructed in the Miami International Airport flight path and had FAA Requirements. The high level segmental flyovers are built over multiple roads that carry 430,000 vehicles per day and are the tightest elevation curves erected in the United States. The all overhead erection method eliminated the need for falsework and cranes, as well as 5 MOT phases that would have impacted traffic, while providing a safer work environment.

CREDITS

Owner: **Florida Department of Transportation**

Owner's Engineers: **AECOM Technical Services** and EAC

Designer: BCC Engineering, Inc. (Prime Design Consultant) and **Finley Engineering Group, Inc. (Segmental Bridge Design)**

Design-Build Team: Community / **Condotte America, Inc.** / De Moya JV, BCC Engineering, Inc., and **Finley Engineering Group, Inc.**

Contractor: Community / **Condotte America, Inc.** / De Moya JV

Construction Engineering Services: **Finley Engineering Group, Inc.**

Construction Engineering Inspection: AIM Engineering & Surveying, Inc., and **Eisman & Russo, Inc.**

Precast Producer: **Rizzani de Eccher**

Formwork for Precast Segments: **DEAL**

Erection Equipment: **DEAL**

Post-Tensioning Materials: **VStructural, LLC (VSL)**

Bearings: **D.S. Brown Company**

Expansion Joints: **D.S. Brown Company**

Epoxy Supplier: **Sika Corporation** and Pilgrim

Prepackaged Grout: The Euclid Chemical Company

U.S. 281 Bridge Over Colorado River

The new U.S. 281 Bridge over the Colorado River replaces a functionally obsolete steel truss bridge with a 958' long segmental bridge. The bridge design by the Texas Department of Transportation (TxDOT) along with design innovations from the Contractor-Engineer team created a highly aesthetic bridge with a minimal footprint in the water. The bridge was completed on October 9, 2014.

U.S. 281 is a major north-south highway from Wichita Falls to San Antonio and serves as an important evacuation route and emergency services access for the area. Factors leading to selecting a cast-in-place segmental design include:

- *The nearest river crossing detour is located 30 miles north.*
- *Limited site access and right-of-way due to adjacent businesses and utilities restricting an alignment change.*
- *Active recreational lake traffic in the area that is reliant on tourists.*
- *High local regard for the look of the old truss bridge.*

There are 24 concrete segments per cantilever, with 48 segments total per bridge. Each segment measures 14' to 16' long and 47' wide. The variable segments sport a unique tapered boat hull design in the bottom slab, an aesthetic treatment that matches the community's focus on recreational boat racing. The segments have a box depth that ranges from 23' at the interior piers to 9'5" at the end spans, with a variable superelevation up to 5.5%. Each segment weighs a maximum of 150 tons.

Innovation of Design and/or Construction

- The major changes proposed by the Contractor-Engineer team included revising the pier table design, segment layout and post-tensioning specifications. The design modification called for an unbalanced design (22' x 14' from centerline of column). This required less falsework, and only two temporary supports during construction on a reduced schedule.
- Temporary shoring for the prop drilled shafts which were incorporated into the pier table falsework.
- The transverse and longitudinal post-tensioning was modified to utilize 4 strand tendons at 2'9-1/2" spacing. This modification saved on duct, heads, grout, caps and allowed for smaller stressing anchors in some areas.
- While reducing the length of each segment required more segments, the process of pouring each segment using the form travelers was optimized, and required less labor-intensive falsework to be built.
- Cofferdams could not be used due to hard limestone rock at the bottom of the lake, close proximity to the existing bridge, and the need to maintain an open water channel for boating traffic. The design modification called for drilling shafts into the rock riverbed and lowering an on-site precast concrete footing form to accommodate the forms and the work platform.

Rapid Construction

- The structures were built with two form travelers using balanced cantilever construction, with end segments constructed on falsework.
- The modified pier table length allowed for a significant reduction in falsework. The unbalanced design also eliminated the need for a stability prop on both sides of the pier. This reduced approximately 12 weeks off the construction schedule and maintained the horizontal clearance envelope throughout construction.
- Since it was desirable to limit the drilling in the water, the Contractor's Engineer developed an innovative approach for the pier table falsework and stability prop design. The prop also served as the support for the main pier table falsework beams.
- The Contractor's Engineer used Bridge Information Modeling (BrIM) which made it possible to develop details quickly to meet the demanding schedule.

Jury Comments

Reused form travelers from another project resulted in cost and time savings. Highly aesthetic shape in an area with heavy recreational boat traffic. Innovative precast footing box allowed footings to be placed below the waterline without cofferdams. The perfect fit to meet this project's diverse demands of the traveling public, local environment, and surrounding community. The boat-shaped hull bottom slab, tapered piers, absence of visible foundations, and lighting have combined to produce a beautiful bridge day or night.

CREDITS

Owner: **Texas Department of Transportation**

Owner's Engineers: **Texas Department of Transportation Bridge Division**

Designer: **Texas Department of Transportation** and **Finley Engineering Group, Inc.** (Alternative Superstructure Design and Construction Engineering)

Contractor: **Archer Western Contractors**

Construction Engineering Services: **Finley Engineering Group, Inc.**

Constructability Review/Estimating Services: **Archer Western Contractors**

Construction Engineering Inspection: **Texas Department of Transportation**

Formwork for Precast Segments: **Doka USA, Ltd.** (Cast-in-Place Segments)

Form Travelers for Cast-in-Place Segments: **VStructual, LLC (VSL)**

Post-Tensioning Materials: **VStructual, LLC (VSL)**

Bearings: Dynamic Rubber

Expansion Joints: CMC Capital City Steel

Prepackaged Grout: Masterflow 1205

Roadway and Hydraulic Design: **Jacobs Engineering, Inc.**

Aesthetics and/or Harmony with Environment

- The public was very sensitive to the aesthetics of this bridge since the lake is also used for recreation.
- The variable segments feature a unique tapered boat hull design in the bottom slab, an aesthetic treatment that matches the community's focus on recreational boat racing. A flared column design with a seamless transition between the pier and pier table required a custom built form poured in two pieces, with 6' of column base, 3' under the normal water level.
- To maintain a minimal footprint, traditional footing was not used. Pier table falsework was designed with bolted connections to ease installation and removal. Drilled shafts were designed to stop at the mud line. The props incorporated sand jacks to aid in removal by slowly relieving the 1000 kip per leg load.

Cost Competitiveness

The Contractor secured two form travelers that met the specifications for this project which resulted in cost savings of $750,000 and several month's reduction to the schedule for design and fabrication of new travelers. These and other design modifications met all the goals of the project providing approximately $2 million savings, 5% below the TxDOT estimate.

- Cost per square foot is $206.74

Minimization of Construction Impact on the Traveling Public

Since the closest river crossing was over 30 miles away, this bridge crossing had to remain open continuously, requiring phased construction.

All Photos Courtesy of Archer Western Contractors