

## PROJECT

# RAMP N-N OVER I-17

Rebuilding the gateway to northern Arizona in Cordes Junction

by David B. Benton, Arizona Department of Transportation

As a regular destination for motorists to the Flagstaff or Prescott region, the junction of I-17 and SR 69 has been described as the gateway to northern Arizona. But in recent years, the outdated Cordes Junction traffic interchange had started to show its age.

Built in the early 1960s, the Cordes Junction traffic interchange carried far more traffic than it was designed to accommodate. With traffic volumes expected to double in the coming decades, the Arizona Department of Transportation (ADOT) began a daunting task in the summer of 2011 to redesign and rebuild the busy interchange—which is located approximately 65 miles north of downtown Phoenix—with minimal disruption to traffic.

The solution was a reconstruction project that would transform the outdated intersection design and replace it with a modern interchange that could handle the increased traffic in the area. No longer would slower local traffic have to mix with high-speed highway traffic, causing congestion and safety concerns. Two years after construction started, ADOT completed the project on budget and on time in the summer of 2013.

### Project Challenges

The junction of I-17 and SR 69 in central Arizona provides a vital link between the metropolitan Phoenix area to the south, the surrounding communities of Humboldt, Dewey, Prescott Valley, Chino Valley, and the city of Prescott to the north. Reconstruction of the Cordes Junction traffic interchange was a key

project to ADOT to improve operational characteristics, geometrics, and safety at this interchange.

The existing underpass (UP) at this traffic interchange, known as Cordes Junction TI UP, consisted of a four-span continuous steel girder bridge consisting of five girder lines with maximum spans of 86 ft 3¼ in. and 79 ft 3¼ in. skewed at approximately 31 degrees over northbound and southbound lanes of I-17. The bridge needed to be replaced with the reconstruction of the traffic interchange due to the inability to accommodate the future widening of I-17 and substandard vertical clearance and shoulder widths. In addition, it conflicted with improvements needed at the traffic interchange to facilitate a connector road to SR 69 and the community of Cordes Lakes, east of this location.



Paolo Soleri, a renowned Italian-American architect, partnered with ADOT on Cordes Junction I-17/SR 69 traffic interchange project. His artistic vision is on display on the abutments, wing-walls, and retaining walls at the project. Photo: Arizona Department of Transportation.

## profile

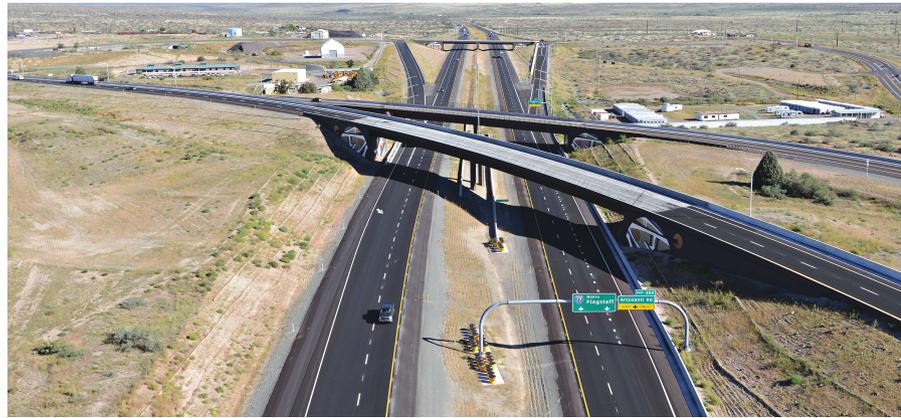
### RAMP N-N OVER I-17 / CORDES JUNCTION, ARIZONA

**BRIDGE DESIGN ENGINEER:** Arizona Department of Transportation Bridge Group, Phoenix, Ariz.

**PRIME CONSULTANT:** HDR Engineering Inc., Phoenix, Ariz.

**PRIME CONTRACTOR:** Vastco-Sundt Joint Venture: Vastco Inc., Chino Valley, Ariz., and Sundt Construction, Tempe, Ariz.

**POST-TENSIONING CONTRACTOR AND SUPPLIER:** DWYIDAG-Systems International, Long Beach, Calif.



Originally constructed in the early 1960s, the Cordes Junction traffic interchange at the junction of Interstate 17/SR 69 needed replacement due to heavy traffic in the area. The new Cordes Junction I-17/SR 69 traffic interchange was designed to improve traffic flow and safety, while separating local and highway traffic. Photos: Vastco-Sundt.

The scope of the project included

- replacing the existing Cordes Junction TI UP,
- replacing adjacent bridges over Big Bug Creek to the south,
- providing a new diamond interchange to the north with access to the unique community of Arcosanti,
- building a new connector road bridge linking the community of Cordes Lakes to SR 69,
- constructing two new overpass bridges on SR 69 linking Cordes Lakes Road and Arcosanti Roads to businesses along Copper Star Road to the west, and
- adding a directional ramp linking I-17 northbound travel to northbound SR 69 known as Ramp N-N.

### Delivery Method

During the initial stages of development, ADOT approached the project with a traditional design-bid-build delivery method. After reaching the 30% design milestone and the selected interchange configuration was agreed upon by the project team, it was apparent the project offered many challenges, mainly due to complexity of reconstructing the

traffic interchange, maintaining two lanes of traffic open in each direction on a busy interstate, and keeping the connection of I-17 and SR 69.

The total reconstruction of the Cordes Junction traffic interchange was estimated at \$50.9 million. With a challenging task of reconstructing a traffic interchange with estimated daily traffic volumes of over 27,000 vehicles on I-17 and 13,000 vehicles utilizing the existing interchange, ADOT was seeking a new and innovative way to approach construction.

The department decided to embark on a fairly new concept to ADOT on construction delivery and construct the traffic interchange utilizing a construction-manager-at-risk approach. This delivery method was the first of its kind at ADOT that involved heavy bridge construction on the interstate, through live traffic, and use of federal funds. The key factors to this decision were maintenance of traffic and having a qualified contractor on-board to perform the construction and provide preconstruction services. This assisted the design team in construction sequencing and traffic phasing to

meet the requirements of the project for I-17 travel and keeping the existing interchange accessible.

### Bridge Type

One of the key components of the reconstruction of the Cordes Junction traffic interchange is the new directional ramp connecting northbound I-17 travelers to northbound SR 69, known as Ramp N-N. Due to the outdated design of the previous interchange, slower traffic destined for the businesses and residences in the Cordes Lakes area were forced to mix with Prescott-bound traffic at this busy traffic interchange until the flyover bridge opened to traffic in December 2012.

The new flyover ramp consisted of a two-span, 397-ft 9<sup>5</sup>/<sub>8</sub>-in.-long structure with unequal spans of 215 and 175 ft to accommodate the ultimate width of I-17 at this location. The bridge is skewed at 40 degrees left, radial to the horizontal curved alignment with a length of 1833.83 ft, a radius of 1660.75 ft, and superelevation of 6%. The Ramp N-N bridge sits within a 1600 ft crest vertical curve with approach and departure grades of 2.04% and -0.62%, respectively.

## ARIZONA DEPARTMENT OF TRANSPORTATION, OWNER

**BRIDGE DESCRIPTION:** Two-span, 397-ft-long, cast-in-place, post-tensioned concrete box girder bridge

**STRUCTURAL COMPONENTS:** Three-cell, cast-in-place concrete box girder with 14-in.-thick webs spaced at 11 ft on center, with 4-ft 6<sup>1</sup>/<sub>2</sub>-in.-long cantilever deck edges

**BRIDGE CONSTRUCTION COST:** \$182/ft<sup>2</sup>

**AWARDS:** Engineering Excellence Grand Award – American Council of Engineering Companies (ACEC) of Arizona 2013

ADOT selected a cast-in-place (CIP), post-tensioned box girder bridge because it best meets the geometric requirements of this directional ramp, provides the lowest initial construction cost, and has minimal maintenance during the life of the structure. Concrete superstructures are the predominate type utilized in the state of Arizona, due to low cost and readily available concrete materials. They provide a durable and resilient end product, built by a proven construction industry skilled in both CIP and prestressed concrete construction. Full-height abutment walls founded on spread footings were selected to minimize span lengths and limitations of superstructure depth with the use of falsework over I-17.

The pier substructure type was originally designed with a two-column integral pier founded on a single shallow spread foundation. However, through the process of review by the contractor during preconstruction services, it was recommended that the footprint needed to construct a spread foundation would be eliminated by using shallow rock sockets. This freed up valuable space in the median of I-17 to be utilized in temporary traffic shifts towards the median area. Having the contractor on-board working side by side with the design team in a preconstruction role, proved to be an invaluable asset to the project team and helped minimize risk and conflicts in construction that may have possibly delayed construction operations and most importantly, the traveling public.

The design of the CIP, post-tensioned concrete box girder bridge consisted of a 9-ft 3-in.-deep, three-cell box with webs spaced at 11 ft on center,



Heavy cranes work on the Ramp N-N constructed abutment wingwall with box girder falsework over Interstate 17. Photo: Arizona Department of Transportation.



This photo shows the Ramp N-N median where the pier columns and abutment are being constructed. Photo: HDR.

augmented with sloped exterior webs at a 4 to 1 ratio and 4-ft 6½-in.-long deck cantilevers. The bridge deck thickness was set at 9 in., based on clear span requirements in ADOT *Bridge Design Guidelines*. A unique update to the ADOT *Bridge Design Guidelines* that was incorporated into this project

was a requirement to use a minimum web thickness of 14 in., based on the depth of the superstructure meeting or exceeding 9 ft. Past experience with consolidation of concrete in webs with standard thicknesses of 12 in. around post-tensioning ducts with deep superstructures exceeding 8 ft had been an issue on some past ADOT projects and the update in the requirements was in line with commentary stated in the AASHTO *LRFD Bridge Design Specifications*, to help rectify some of these concerns. The bottom slab thickness was 6 in. The total post-tensioning force specified for this design was 15,620 kips utilizing four ducts per web with twenty-two 0.6-in.-diameter strands per duct. 

## AESTHETICS

Aesthetic treatments for the bridge were provided utilizing one of the last works by famed Italian-American architect Paolo Soleri, a one-time apprentice under Frank Lloyd Wright.

Soleri, who established Arcosanti, an artists' community and a popular tourist attraction located just two miles northeast of the traffic interchange, served as a project consultant for ADOT prior to his death on April 9, 2013, at the age of 93. Soleri's artistic vision is now on display on many of the retaining walls and abutments on the bridges at the interchange. While most of his artwork was completed prior to his death, his visionary designs will be on display for drivers who pass through the area for decades.

*David B. Benton is the bridge design manager for the Arizona Department of Transportation in Phoenix, Ariz.*