Intricate and creative designs for once-in-a-lifetime bridges garner awards and acclaim, but designers are most in need of ideas for the typical bridges they design and build every day. The Guadalupe County I-40 Overpass bridges, a set of three structures, gave designers with the New Mexico Department of Transportation an opportunity to solve recurring problems, create strong aesthetic appeal, improve durability, and stay under budget. The design, featuring precast concrete U-beams and cast-in-place concrete decks, provides a strong option for many future bridges.

The new structures, which cross I-40, replaced bridges that were functionally obsolete and structurally deficient. Two of the bridges carry local traffic on minor arterial roads, while the third carries U.S. Route 84. The new structures were offset from the original bridges allowing free design within standard roadway parameters. A cross section consisting of two 12-ft-wide lanes with 6-ft-wide shoulders, for a total roadway width of 36 ft and a bridge width of 39 ft, met the standards for the arterial roads. Eight-ft-wide shoulders were required on the U.S. Route 84 bridge, creating a total roadway width of 40 ft and bridge width of 43 ft.

Interstate 40 carries many travelers and tourists, and the bridges welcome people to the state and to Guadalupe County. To enhance that welcome, strong aesthetics were desired for these bridges. The design also had to reflect the local color of the area and be tied together to establish continuity.

Identical Structures Created Efficiency

The designers decided that the easiest way to approach this challenge was to create identical structures for all three bridges, so artwork could then reflect each locality, while the bridges provided continuity. As a result, the design had to fulfill the requirements for all three bridges. This task was simplified because the interstate highway maintained a consistent width throughout the project length. After considering a variety of options, the designers decided to create two-span bridges with a pier in the center of the median.

Large, unconstrained areas of slope paving on steep slopes have created problems in the past, so the team was asked to avoid using steep slopes constrained by slope paving as the support at abutments. Using self-stable slopes would have added 50 to 60 ft to each roadway side, creating spans of about 150 ft, which would have required an increase in road height of 9 in. or more. Mechanically-stabilized earth (MSE) walls proved to be a better value economically and were thought to have better aesthetic potential for the given profile.
unwanted torsional stresses in the webs. That the condition could also cause
harped section. A stress analysis indicated
constant throughout the length of the
position relative to the web edge is not
presented difficulties, since the strand
harping the strands for these beams
(now Coreslab Structures) indicated that
Discussions with staff at Rinker Materials
are wider at the top than the bottom.
U-beams do not accommodate
reduced congestion, especially at the
ends. U-beams do not accommodate strand harping easily because the webs
slope at 1.5:1 vertical to horizontal and
are wider at the top than the bottom.

Strand Congestion Alleviated
The beams contain 0.6-in.-diameter
prestressing strands, which allowed fewer strands to be used. This approach
reduced congestion, especially at the
ends. U-beams do not accommodate strand harping easily because the webs
presented difficulties, since the strand
position relative to the web edge is not
constant throughout the length of the
harped section. A stress analysis indicated
that the condition could also cause unwanted torsional stresses in the webs.

The other alternative was to debond strands at the ends of the beams. The
increased bursting force, however, due
to the larger diameter strands required
special consideration. The solution was
to add strands in the top flange and
debond them in the midspan region.
The debonded top strands were cut
at the center after release and before
beam erection. The timing of the cutting
was decided by the supplier to assist
with control of beam camber. The top
strands also made placement of other
reinforcing steel easier. The supplier now
recommends the use of top strands in U-
beams whether required by design or not.

The torsional stability of the U-beams
eliminated the need for exterior
diaphragms, making construction easier
and enhancing the form of the bridge.
Interior diaphragms were provided at
third points along the length of the beam
to prevent beam rotation. Solid interior
diaphragms also were provided at the
ends of the beams to accommodate the
reinforcement required for the integral
abutments and confinement for the
anchorage zones.

Three-Point Bearing System Used
New Mexico has experienced several
problems relating to bearing and torsional
rigidity with both U-beams and large box
girders. To address these issues, a three-
point bearing system was designed for
the U-beams. Two bearings per beam
were placed at the pier and one bearing
per beam was placed at each abutment.
The arrangement allowed the beam to
rotate on the single bearing and provided
uniform bearing on the remaining two.
Small, lightweight angles were added at a
distance away from the bearings to retain
the bearings if displacement occurs. To
date, there has been no displacement
and the bearings are performing well.

By grouping the three projects together,
incredible time savings in construction
were achieved. The three projects were
completed in approximately one year. In
addition to the time savings from working
simultaneously on all three projects, the
uniform design eliminated the learning
curve on two of the bridges, reducing
construction time for each activity.
Producing similar beams also saved time
in reconfiguring molds, jigs, etc.

The approach slabs used New Mexico’s
standard design, which consists of a 14-
ft-long by 11-in.-thick slab that moves
with the deck. The slabs are supported
by the abutment on the bridge end
and by a sleeper beam on the roadway
end. Abutments are semi-integral with
a short stub wall supported on spread
footings. A diaphragm poured integrally
with the deck is placed across the entire
stub wall, developing integral movement
between beam ends, deck, and approach
slab. Elastomeric bearings are used to
ensure uninhibited movement of the
superstructure.

The wingwalls are also integral with the
deck and diaphragm. To alleviate the
problems of movement between the
fixed stubwall and the movable wingwall,
the stub wall was shortened on each
end. The wingwalls were designed to be
alongside the stubwall instead of behind
it. Bituminous bond breakers were placed
between the wingwalls and the stub wall ends and footings. The design allows the wingwalls to slide back and forth freely beside the stub walls. The location of the wingwalls also locks the superstructure to the substructure transversely aiding in the elimination of sole plates.

**Artwork Added**

To fulfill the aesthetic requirements of welcoming visitors, 3D modeling with a basic rendering assisted with visualization of the completed form. Girders, piers, and MSE walls were designed to complement one another and provide an overall pleasing form.

Artwork was incorporated into the MSE walls, wingwalls, piers, and barrier curbs, using a technique of disposable foam or plastic of a given thickness to create recessions in the concrete. The recessed areas were painted in contrasting colors to the background. Recessed areas give definitive paint boundaries, which provide ease in initial and maintenance painting. The cost for forming and painting with this system was minimal with respect to the cost of other art systems.

The average unit costs for bridge structures on this project was $84 psf, slightly less than the average unit cost of $86 psf for all bridges in New Mexico that year. The cost effectiveness can be attributed to several factors, including simplicity and construction considerations in design; consultation during design with suppliers and contractors to develop easy-to-build and economical details; use of repetitive parts and materials throughout all three bridges; and a creative bid process that let contractors bid one bridge, any combination of two bridges, or all bridges on this project.

The New Mexico Department of Transportation was very pleased to get three attractive bridges at a cost that was comparable to that of other bridges. The careful planning and good communication throughout the design and construction process was responsible for the creation of three bridges that are aesthetically pleasing, structurally efficient, cost effective, and durable.

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Credit:
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PROJECT

GUADALUPE COUNTY I-40 OVERPASS BRIDGES / GUADALUPE COUNTY, NEW MEXICO

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