

State Highway 183 MacArthur Boulevard Overpass Emergency Repair

Irving, Texas

Submitted by Sika Corporation

State Highway 183 is a major east/west highway between Dallas and Fort Worth, TX. It is also the major route to the south entrance of Dallas/Fort Worth Airport. The highway carries three lanes of traffic in each direction. The average daily traffic (ADT) count for the east-bound lanes is 91,000.

MacArthur Boulevard is a major north/south arterial route carrying two lanes of traffic in each direction through Irving, traversing from Coppell in the north to I-20 in the southern portion of the Metroplex. The ADT on MacArthur is 32,000.

The State Highway 183 bridge structure over MacArthur Boulevard, constructed in 1953, consists of two abutments and three bents that support a series of parabolic beams. The beams are further strengthened by diaphragms, and all this supports a concrete deck with an asphalt overlay. The bridge was widened in 1969 to make it two 36 ft (11 m) wide roadways with 12 ft (3.7 m) shoulders and a center traffic barrier. All of the elements are cast-in-place reinforced concrete.

Problems that Prompted Repair

On the morning of Saturday, May 28, 2005, a 3000-gal. fuel tanker heading east on State Highway 183 barreled through a guardrail and spiraled off a bridge at about 6:30 a.m. before landing upside down and exploding on MacArthur Boulevard. The explosion severely burned and cracked the highway's concrete bridge. It took firefighters 30 minutes to extinguish the blaze. Officials initially closed all lanes in both directions of both roads before reopening State Highway 183 westbound lanes at 11:15 a.m. It took 11 hours to clean up the wreckage. There was extensive heat, and the concrete on the bridge columns and beams spalled and "popped" as a result.

Later that afternoon, state transportation officials placed concrete barriers on eastbound State Highway 183 to block off the two right lanes and prepared to open one eastbound lane and both service roads



Fig. 1: View looking east of the charred remains of Bent 4 and adjacent areas

Saturday evening. State transportation officials indicated this State Highway 183 could be limited to one lane for up to 3 weeks.

It was believed that the MacArthur Boulevard underpass probably would not reopen until the bridge was repaired. Gazing at the charred structure, Texas Department of Transportation (TXDOT) engineers said they had never seen anything like the combination of bridge damage and potential traffic headaches confronting them on State Highway 183 due to this accident.

Inspection/Evaluation Methods

By Tuesday, May 31, TXDOT engineers had spent hours scouring every nook and cranny of the blackened, flaking structure over MacArthur Boulevard. Visual inspections defined the general areas of needed repairs. This was further investigated by sound tapping with hammers to better define the damaged areas. Selected demolition was performed to gain a better understanding of the concrete quality and the bond of the concrete to the steel and to identify any possible voids between the steel and the concrete.

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Fig. 2: TXDOT engineers inspect the damage

Four cores were taken from the columns and caps with the most severe fire damage. These cores were visually inspected by TXDOT engineers to determine if the fire had affected the structural integrity of the bridge. Examination of the cores revealed that the fire had not damaged the inner reinforcing steel and concrete.

After the thorough evaluation, TXDOT engineers concluded that although the damage was extensive, the bridge could be repaired.

Repair System Selection

Having completed the investigation, plan development began immediately. Repair solutions were evaluated and project documents developed and completed. Sealed plans were delivered to the area office on June 10.

The scope of work and materials included the following:

1. Columns 6 through 10 along Bent 4:
 - Remove delaminated concrete;
 - Repair using wet spray-applied fiber-reinforced mortar with 3000 psi (21 MPa), 24-hour compressive strength;



Fig. 3: Removal of delaminated concrete along the beams and deck

- Strengthen by wrapping the columns with carbon fiber-reinforced polymer (CFRP); and
- Put elastomeric, breathable coating over the CFRP for UV stability and aesthetics.

Note: Columns 6 and 7 did not require CFRP, and all concrete repair areas exceeding 2 in. (5 cm) in depth required the placement of 2 x 4 in. (5 x 10 cm) welded wire mesh mechanically fastened to the substrate prior to the placement of the repair mortar.

2. Beams 12 through 18 between Bents 3 and 4 and Abutment 5:

- Remove delaminated concrete;
- Repair using wet spray-applied fiber-reinforced mortar with 3000 psi (21 MPa), 24-hour compressive strength;
- Strengthen by wrapping the beams with CFRP;

a. Layer on the bottom of the flange; and
 b. 12 in. (30 cm) wide “U”-wraps 2 ft (61 cm) on center on the sides and bottom along the length of the beam.

- Put elastomeric, breathable coating over the CFRP for UV stability and aesthetics.

3. Bent 4 above Columns 7-8 and 9-10:

- Remove delaminated concrete; and
- Repair the two caps by encapsulating and combining them into one large “straddle” bent using form and pump concrete.

4. Beam bearing seats along south end of Bent 4:

- Repair conventionally with concrete

5. Deck repairs to underside of southeast area:

- Remove delaminated concrete; and
- Repair using wet spray-applied fiber-reinforced mortar with 3000 psi (21 MPa), 24-hour compressive strength.

6. Deck repair to topside of southeast area:

- Remove and replace asphalt

7. Bridge rail in southeast area:

- Retrofit with a new T-501 nail

Project Installation

A June 13 prebid meeting was held on site with plans delivered to the bidders at this time. Bids were



Fig. 4: Installation of CRFP to Column 10



Fig. 5: Wet-spray shotcrete applied to underside of beam



Fig. 6: Completed substructure looking northwest. Bent 4 with the large "straddle" bent is in the foreground

due June 16. The bids were reviewed and the project was awarded to a general contractor, and contracts were signed that same day. June 18 was the official start date of the project.

The project was to be a 24/7 operation, including holidays. Project completion was scheduled for July 19 with a \$10,000 per day liquidated damage penalty.

Site Preparation

The right-hand lane plus the shoulder on eastbound State Highway 183 remained closed until project completion (two eastbound lanes remained open). Northbound MacArthur Boulevard remained closed throughout the project. Northbound traffic was diverted to one lane on the southbound side.

On June 18, full platform scaffolds were erected to provide simultaneous access to all repair areas.

Demolition Method

Demolition of the beams started on June 19 at the south side of the bridge between Bent 4 and Abutment 5 and proceeded northward. Originally, it was estimated that 500 ft³ (14.2 m³) of concrete required removal. It quickly became evident that this quantity would be exceeded. Ultimately 1000 ft³ (28.3 m³) of concrete was removed.

Surface Preparation

After bulk demolition, the concrete and exposed reinforcing steel were sandblasted. Just prior to placing the repair materials, the substrate was water blasted for a final clean and to achieve a saturated surface-dry condition.

Application

Columns, beams, diaphragms, and the bridge deck were all repaired using high-velocity, wet-spray application. Two pumps were used with a third on hand to serve as a backup.

Two-sided wood forms were fabricated to enable the placement of the mortar while maintaining the unique parabolic shape of the beams. The Bent enlargement was formed and poured. The CFRP was laid by hand, wet.

The repair contractor worked crews of six to eight men for 10-hour shifts each, two shifts a day, 7 days

a week. During demolition it became evident that the required removals significantly exceeded that originally estimated. To ensure the completion date would be met, a second repair contractor was hired to spray the beams between Bent 4 and Abutment 5 while the first repair contractor continued with demolition and surface preparation. A third contractor was hired to form and pour the concrete at the large straddle bent, which required 12 yd³ (9 m³) of concrete.

Next, the general contractor installed the CFRP and the guardrail. After placement of the CFRP, the beams and columns were coated with an elastomeric coating to provide UV protection to the epoxy/CFRP system and a more uniform appearance to the structure. Finally, a paving contractor removed and replaced the asphalt overlay. The project was completed July 15, 2005, 4 days ahead of schedule.

State Highway 183 MacArthur Boulevard Overpass

Owner

Texas Department of Transportation (TXDOT)
Dallas Northwest Area Office
Dallas, Texas

Project Engineer/Designer

TXDOT Dallas District 18
Dallas, Texas

General Contractor

Gibson & Associates
Balch Springs, Texas

Subcontractor

Mobile Enterprises, Inc.
Fort Worth, Texas

Material Supplier/Manufacturer

Sika Corporation
Lyndhurst, New Jersey