Case Study

U.S. Department of Transportation
Federal Highway Administration

TOPS
Targeted Overlay Pavement Solutions

CONCRETE OVERLAY
DELAWARE I-495
Concrete on Concrete–Unbonded

Concrete on concrete–unbonded (COC–U) overlays allow the existing pavement structure to be retained as a base layer, even when the existing concrete is affected by alkali-silica reactivity (ASR). This case study summarizes the design, construction, and performance of a successful COC–U overlay of an existing continuously reinforced concrete pavement (CRCP).

INTRODUCTION

Every two years, the Federal Highway Administration (FHWA) works with State transportation departments, local governments, tribes, private industry, and other stakeholders to identify and champion a new collection of innovations that merit accelerated deployment through the Every Day Counts (EDC) program.

The EDC-6 program launched on September 23, 2020. One of the innovation areas is Targeted Overlay Pavement Solutions (TOPS).

Many pavements in the highway system have reached or are nearing the end of their design life while carrying traffic that exceeds their initial design criteria. TOPS can help agencies retain their investment in the engineered layers of existing pavement structures while creating longer-lasting, safer roadways. Concrete overlays can extend the service life of existing asphalt, concrete, and composite pavements without reconstruction, thereby improving safety for workers and roadway users. Finally, concrete overlays can help to reduce the life-cycle cost of pavement ownership.

Delaware DOT

Figure 1. Concrete overlay on I-495 in Delaware in 2020: (a) going northbound and southbound and (b) close-up view of the overlay

PROJECT BACKGROUND

This project was located along a 9-mile-long section of I-495, the bypass freeway around Wilmington, Delaware, that spans three lanes in both northbound and southbound directions (Figure 1). Most of the existing pavement consisted of a 9-inch-thick CRCP placed over a 4-inch-thick cement-treated base (CTB), with the rest consisting of a 10-inch-thick jointed reinforced concrete pavement (JRCP). The shoulders were typically 3 to 4 inches of asphalt concrete (AC). Both types of pavement were constructed between 1972 and 1977 and were opened to traffic in 1978.

In 1990, the Delaware Department of Transportation (DelDOT) initiated a comprehensive study to evaluate rehabilitation strategies for I-495 and the associated ramps. Major concerns included extensive ASR in the CRCP sections, which manifested as parallel longitudinal cracks that were becoming more frequent and wider, and extensive ASR-related joint deterioration in many of the JRCP sections. The potential for ASR distress was not well known at the time I-495 was constructed.

Based on the results of the 1990 study, DelDOT in 1991 initiated a project-level pavement investigation and design study for the I-495 roadway. The field investigation consisted of a visual condition survey, nondestructive deflection testing using a falling-weight deflectometer (FWD), and coring and boring. The field investigation identified the following:

1. The longitudinal ASR-related cracking in the northern portion of I-495 was more pronounced than in the southern portion, and truck traffic caused more damage within the wheelpath locations. This resulted in the need for many patches in the wheelpath areas.
2. The ASR-related longitudinal cracking development and deterioration was expected to continue, resulting in a continual need for aggressive pavement repair activities and lane closures.
3. The CRCP was constructed on a sound CTB and a relatively free-draining layer of coarse to fine sand, and no drainage-related distress was evident.

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FHWA CONTRACTING OFFICER'S REPRESENTATIVE
Sam Tyson, Concrete Pavement Engineer
Federal Highway Administration
1200 New Jersey Avenue, S.E.
Washington, DC 20590
202-366-1326, sam.tyson@dot.gov

AUTHOR
Shiraz Tayabji
Advanced Concrete Pavement Consultancy, LLC

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4. The projected traffic for 2010 ranged from 59,000 to 84,000 vehicles per day. The projected 20-year cumulative equivalent single-axle loads (ESALs) (from 1990 to 2010) were estimated to be 59,000,000. The 40-year cumulative ESALs were estimated at 166,000,000. This level of traffic loading is considered to be significant and on the high side.
5. As a result of the extensive ASR-related damage to the pavement and the anticipated high volume of traffic, it was clear that a robust pavement rehabilitation strategy would be needed soon. Typical concrete pavement restoration techniques were not considered feasible because of the ASR distress.

After a review of several rehabilitation strategies, DelDOT selected an unbonded jointed plain concrete (UJPC) overlay with a 15-foot transverse joint spacing. A UJPC overlay allowed the use of the existing pavement structure, retained the ASR-affected concrete at the project site, and considerably reduced construction time, resulting in less disruption to traffic.

PROJECT DETAILS

The concrete overlay was designed using the American Association of State Highway and Transportation Officials (AASHTO) 1986 *Design Guide of Pavement Structures*, specifically the 1991 Proposed Revisions to Chapter 5. Based on the design data developed during the 1991 project-level study, a 10-inch-thick concrete overlay was initially considered adequate for a 40-year design. However, because of the importance of I-495 for traffic using the I-95 corridor from Maine to Florida, DelDOT decided to increase the overlay thickness to 12 inches to ensure a longer lasting pavement over the first 20 to 25 years of service life. The pavement design also incorporated a nominally 2-inch-thick asphalt concrete interlayer and 12-foot-wide outside tied concrete shoulders to serve as potential travel lanes in the future.

The concrete overlay for the northbound section was constructed in 1993, and the overlay for the southbound section was constructed during 1994.

PROJECT PERFORMANCE

According to DelDOT, the UJPC overlay is performing well after more than 26 years of service. DelDOT expects the UJPC to continue to provide improved rideability and safety for road users. The 2018 traffic volume along I-495 ranged from 66,000 to 103,000 at different points on the highway; traffic volumes increased 12-22% over the 2010 projected traffic. The project has maintained the as-constructed smooth ride and has had only minor maintenance activities such as joint spall repair, crack and joint sealing, and patching in the shoulder. In 2010, the entire length of I-495 and the associated ramps were patched, spalling was repaired, and cracks and joints were sealed.