0-4893: Performance of Old Concrete Under Thin Overlays

Background

There are many miles of portland cement concrete (PCC) pavements in Texas that have provided satisfactory performance for much longer than their original design lives. Some of them are still in good structural and functional condition, while some of them were under-designed for the traffic they have served, although they were adequately designed at the time the pavement was built. These under-designed pavements still present valuable assets to the Texas Department of Transportation (TxDOT), and with adequate rehabilitation, these pavements will provide good performance for many years to come.

Bonded concrete overlay (BCO) provides one of the most cost-effective options to rehabilitate these pavements. Over the years, TxDOT placed BCOs in a number of structurally deficient pavements, and most of them have provided excellent performance.

What the Researchers Did

The performance of BCO projects was evaluated in terms of BCO's ability to enhance the structural capacity of the pavement system and to provide long-term serviceability without serious distresses.

Deflection testing using a Falling Weight Deflectometer (FWD) and a Rolling Dynamic Deflectometer (RDD) was conducted and deflections were evaluated. A visual condition survey was performed to evaluate long-term serviceability of BCO. Coring was done to evaluate the condition of concrete under BCO. Distress mechanisms in BCO are different from those in conventional portland cement concrete (PCC) pavement. A combination of strain and temperature gages was installed in a BCO project. Strain gages were placed vertically and horizontally at the interface between old and new concrete layers.

What They Found

The condition of concrete under BCO was satisfactory, with no evidence of deterioration due to chemical reactions such as alkali-silica reaction. BCO enhanced structural capacity of the pavement system, as shown in the figure on page 2. This figure shows deflections in ten 4 inch thick test sections built in 1986 on IH 610 in Houston. It indicates 4-inch BCO reduced deflections by on average one-third. The performance of most of the sections was excellent for the last 20 years. RDD data also shows beneficial effects of BCO on reducing deflections. The reduced deflections are responsible for the good performance. Field survey indicated that delaminations at the interface between old and new concrete layers were responsible for most of the distresses.

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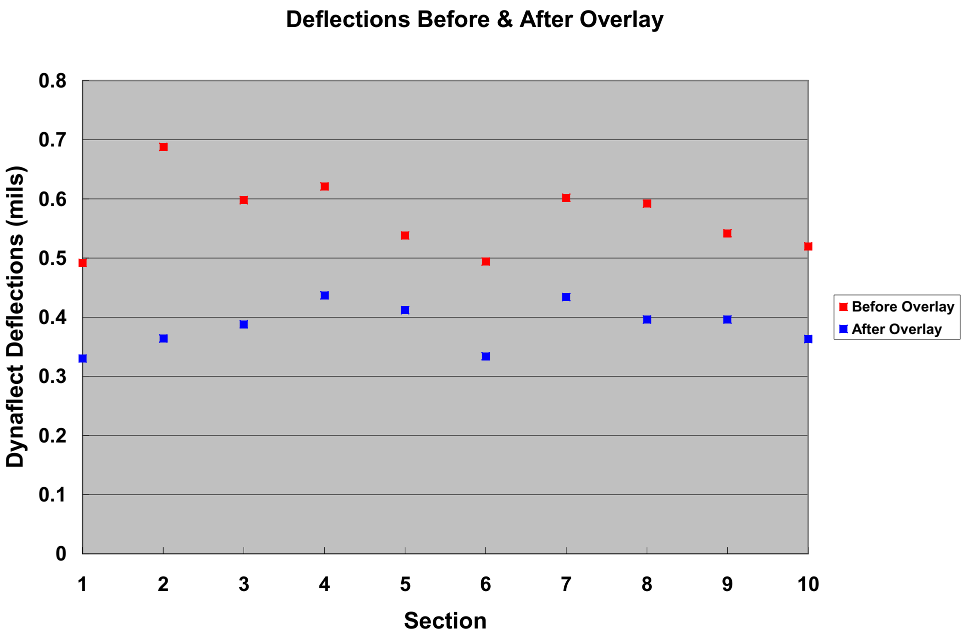

Data from the field instrumentation for identifying the causes of delaminations illustrates that debonding occurred due to normal stresses (Mode I failure), not shear stresses (Mode II failure). As for the effects of concrete material properties in overlaid layer on BCO performance, concrete with lower coefficient of thermal expansion (CTE) and modulus performed much better than concrete with higher values in CTE and modulus, regardless of the concrete properties in the existing concrete layer. Lower CTE and modulus reduced concrete stresses at the interface resulting from temperature and moisture variations in concrete. The reduced stresses ensured good bonding of new concrete to the old concrete, and better performance. Although steel fibers appear to provide benefits in thin bonded overlays (up to 2 inches), for 4 inch or thicker overlays, steel fibers did not provide good performance. On the other hand, continuous reinforcement near the interface provided satisfactory performance. The condition of existing pavement does not appear to have substantial effects on the performance of BCOs, unless existing pavement is severely damaged. Delaminations were observed along longitudinal warping joints and transverse joints.

What This Means

BCO performance can be substantially enhanced by proper pavement design, material selection, and construction practices. They include:

1) Proper overlay thickness considering future traffic and the structural condition of existing pavement,
2) Continuous reinforcement near the bottom of the overlay,
3) The use of coarse aggregate with a low CTE and modulus of elasticity,
4) The use of optimized aggregate gradations to minimize CTE and drying shrinkage,
5) Efficient curing to minimize drying shrinkage, and
6) Achieving adequate durability and strength of concrete while minimizing cement content to control heat of hydration.

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