Florida Department of Transportation Research

Sealing of Cracks on Florida Bridge Decks with Steel Girders
BDK82 977-02

Transverse cracking is common in concrete bridge decks, degrading both aesthetic and structural properties of the bridge. Cracks expose reinforcing steel and supporting steel to corrosive agents, such as water or chemicals, which shorten deck service life. Transverse cracks often form early in a deck's life. Studies reveal many causes for these cracks, such as material characteristics, casting sequence, climate conditions, geometry, vehicle loading, and time-dependent effects.

Growth of cracks, once formed, and negative effects on steel components can be mitigated with sealants. Therefore, the goal of this project conducted by University of North Florida researchers was to study sealants and to determine their ability to span cracks and achieve performance criteria such as penetration depth, bond strength to crack walls, elongation, viscosity, penetration, and suitability of sealant type.

Early age transverse deck cracking occurs in hardened concrete, not concrete's very early, plastic stage. A review of the literature revealed top mechanisms that lead to cracking of hardened concrete: drying shrinkage, autogenous shrinkage, and thermal stresses. Drying shrinkage, due to volume changes induced by moisture loss in cement paste, does not cause cracking on its own; rather, even contraction of drying concrete is often prevented by structural elements, subgrade, or the moist interior of the concrete itself. Autogenous shrinkage is a type of drying shrinkage due to self-desiccation or internal drying, typical of concrete when the water-to-cementitious-material ratio is below 0.42. Thermal stresses caused by dissipation of the heat of hydration or ambient temperature changes create tensile stresses that can lead to cracking.

Researchers also examined cracking in existing bridges, using data from ongoing Florida Department of Transportation (FDOT) district surveys and visiting bridges in Pensacola, Jacksonville, and Ft. Lauderdale to investigate

The development of a transverse deck crack, at the right, is examined by taking a core sample.

deck cracking in different structural settings. Core samples were taken in some cases to examine the mechanisms of cracking.

Lab tests of sealants examined several performance criteria: penetration depth, bond strength plus elongation, and crack bonding. Field tests on bridges and slab samples included core sampling to determine crack bonding and depth of sealant penetration. Researchers investigated whether new cracks formed near newly sealed cracks.

Researchers developed a finite element model to investigate factors affecting tensile stresses and crack tendency. The model also checked the live-load deflection limit, an important factor in bridge deck cracking. An Excel spreadsheet predicted deck cracking, accounting for shrinkage, thermal effect, creep, concrete mix design, deck restrain, loading, and environmental effects.

The deeper knowledge of cracking and sealants provided by this project promises to give Florida's numerous bridge decks longer and better service life, reducing maintenance and replacement of these heavily used facilities.

Project Manager: Ivan Lasa, FDOT Materials Office
Principal Investigator: Adel ElSafty, University of North Florida
For more information, visit http://www.dot.state.fl.us/research-center