Control of Concrete Cracking in Bridge Decks: Are We There Yet?

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According to a recent National Cooperative Highway Research Program (NCHRP) Synthesis of Highway Practice, cracking in full-depth, cast-in-place concrete bridge decks continues to be a major concern for bridge owners, particularly in bridge decks exposed to severe environments.[1] Cracks provide a direct path for water and chlorides to penetrate the concrete and reach the reinforcement. This, in turn, can lead to corrosion of steel reinforcement and degradation of the concrete.

Application of wet curing immediately after finishing the concrete surface and continuing wet curing for at least seven days are successful practices to reduce bridge deck cracking. Photo: Michigan Department of Transportation.

Bridge Deck Cracking

The NCHRP report[1] identified successful practices to reduce bridge deck cracking. These generally relate to reducing drying shrinkage of the concrete and reducing temperature differences. Drying shrinkage can be reduced by limiting the amounts of cementitious materials and water in the concrete and by using the largest practical size of aggregate in combination with appropriate construction practices. These practices include avoiding high-compressive-strength concrete, applying wet curing immediately after finishing the concrete surface, continuing wet curing for at least seven days, and applying a curing compound after the wet curing to slow moisture loss from the concrete.

Temperature differences can be controlled by limiting the temperature of the fresh concrete at the time of placement and ensuring that the concrete temperature does not increase too much as the concrete hydrates. Nighttime concrete placement can also be beneficial, particularly in hot climates. Overall, no single effective practice to reduce concrete cracking in bridge decks was identified by the NCHRP report.[1]

Practices tried by some states to reduce shrinkage and shrinkage cracking include the use of supplementary cementitious materials, internal curing using prewetted lightweight aggregate, shrinkage-reducing admixtures, or shrinkage-compensating concrete.

The American Association of State Highway and Transportation Officials' *AASHTO LRFD Bridge Design Specifications*[2] provides requirements for minimum amounts of reinforcement and maximum spacing of reinforcement to control crack widths.Nevertheless, bridge owners find the need to supplement the AASHTO LRFD specifications with their own requirements. The control of cracking in bridge decks for aesthetic, durability, and structural reasons becomes increasingly important as service-life goals are extended and higher-strength concrete, higher-strength reinforcement, and different types of reinforcement are used in bridge construction.

Other Bridge Components

In addition to full-depth, cast-in-place concrete bridge decks, the NCHRP report[1] includes information about cracking in bridge decks with either partial-depth precast concrete panels with a cast-in-place concrete topping or full-depth precast concrete deck panels. Cracking in prestressed and nonprestressed concrete beams, pier caps, columns, abutments, and pile caps is also addressed.

End-zone cracking in prestressed concrete beams is an infrequent occurrence and often can be prevented by revising the detensioning sequence. Cracks that do occur, however, are controlled through the use of appropriate confinement and splitting reinforcement.

Concrete used in substructures also cracks, but far less frequently than the concrete used in bridge decks. Consequently, there appears to be much less concern about cracks in substructures.

References

1. Russell, H. G. 2017. *NCHRP Synthesis 500: Control of Concrete Cracking in Bridges*. Washington, DC: Transportation Research Board of the National Academies.
2. AASHTO (American Association of State Highway and Transportation Officials). 2014. *AASHTO LRFD Bridge Design Specifications*. 7th ed. Washington, DC: AASHTO.

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