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SUMMARY REPORT

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South Carolina
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Review of Class-E Concrete Bridge Decks in South Carolina

STATEMENT OF THE PROBLEM AND SCOPE OF REPORT

Class-E high performance concrete (HPC) has been used on several bridge construction projects in the upstate region of South Carolina. The majority of these bridge decks, although not all, have experienced problems with early-age cracking occurring both before being opened to traffic and immediately thereafter. The cause of this cracking is uncertain. The cracking exhibited in these Class E bridge decks presents a significant obstacle to the wide-spread adoption of high performance concrete materials for bridges in South Carolina. This is significant in that HPC has been demonstrated to enhance the performance and durability of bridge structures and result in significantly lower life-cycle costs. The eventual adoption of HPC will go a long way to reducing the strain on the SCDoT as it works to address the overwhelming issues of the deterioration of the State's highway infrastructure. The primary objective of this research is to determine likely factors contributing to the observed cracking.

The authors present conclusions, based on their review, as to the causes of the observed early-age cracking in Class-E bridge decks in South Carolina. Additional factors affecting early-age cracking and measures intended to reduce the occurrence of early-age cracking are presented. Alternative bridge deck systems are also presented for consideration.

SUMMARY OF CONCLUSIONS

In an effort to determine likely causes of cracking experienced in new Class E high performance concrete bridge decks, sight inspections of nine bridges in the Spartanburg, SC area and a thorough review of construction documentation from three of these sights was carried out. Additionally, a review of the South Carolina State University (SCSU)/South Carolina Department of Transportation (SCDoT) report *A Study of Microsilica Concrete*, from which Class E concrete specifications were derived, and of SCDoT Concrete Specifications was conducted. Finally, a review of bridge deck cracking phenomena and alternative bridge deck designs was carried out.

It is concluded that observed cracking has two likely causes. Early-age shrinkage cracking resulted from poor curing practices. Load induced cracking, appearing shortly after the spans were open to traffic may result from the relatively stiff decks being placed on more flexible bridge superstructures.

The following recommendations regarding concrete mix design, application of design parameters and on site quality control are presented:

1. Provide improved on site quality control/quality assurance in all aspects of mixing, placing and curing when high performance concrete is used.

2. Develop a more appropriate high performance concrete mix design for use in bridge decks. Such a concrete mix will have enhanced durability characteristics although may not be a high strength mix.

3. Review pour sequence documentation and ensure that pour sequence does not lead to large stresses in previously placed segments. It is important to initiate the sequence of pour in the positive moment regions prior to the negative moment regions.

4. Adopt FHWA parameter characterization for the specification of high performance concrete mixes

5. Include likely vibration or deflection effects associated with more flexible bridge superstructures in the design of the bridge deck.

6. Provide clear guidance for acceptance criteria for high performance concrete mix designs. In particular, it is necessary to clarify the relationship between 56 day design strength and a 28 day strength for acceptance of HPC mixes.

Alternative high performance bridge deck systems are reviewed and the following recommendations for future directions intended to ensure the integrity of new and traditional bridge decks in South Carolina are made.

1. Develop appropriate standards for high performance concrete for bridge decks in South Carolina. Such standards should include mix parameters, placing and curing guidelines and performance standards.

2. Investigate issues of permeability of concrete – in particular, establish a database of permeability parameters for representative concrete mixes in order to establish guidelines for designing relatively impermeable mixes.

3. Investigate alternative high performance bridge deck designs and details with particular attention paid to the service environment in which they will perform.

This research project was conducted at the University of South Carolina by Michael F. Petrou, Ph.D. and Kent A. Harries, Ph.D.
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