RESEARCH NOTES

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Caltrans

Concrete Bridge Deck Crack Sealing: An Overview of Research

RESULTS: ***The study reviewed previous research regarding the effectiveness of concrete bridge deck sealers, the results of a nationwide survey investigating the effectiveness and state of practice of using methacrylate as a crack/surface sealer. Although a wide range of application temperatures was reported in the literature, a range of application temperatures between 7 and 29 ^{o}C is generally recommended. Cracks should be sealed as soon as possible to make sure that chloride concentrations do not reach the corrosion threshold value. For old decks careful attention should be paid to the preparation method and cleanliness of both deck surface and cracks. For areas not subjected to deicing chemicals/chloride-laden environment, HMWM can nearly restore the full bond and flexural strengths if cracks are narrow and free of contaminants.***

Why We Pursued This Research

Cracking in concrete bridge decks is widely regarded as a long-term durability and maintenance problem that requires attention. It is a problem that occurs in most geographical locations and climates, and in many types of bridge superstructures. These cracks propagate through the deck allowing rapid ingress of moisture and chloride ions into concrete interior leading to excessive deterioration due to rebar corrosion. Popular measures to minimize rebar corrosion are to apply surface treatment sealers, which decrease the overall permeability of concrete, and/or to seal/fill the cracks to prevent the direct intrusion of chloride bearing water. In California, High Molecular Weight Methacrylate (HMWM) has been frequently used as crack sealers with millions of dollars spent annually on work involving Methacrylate applications on state owned bridges.

While focusing on HMWM as a crack sealer/filler, the objectives of this research include:

- A thorough review of previous research regarding the effectiveness of concrete bridge deck sealers.

- Nationwide survey investigating the effectiveness of using Methacrylate as a sealer.

- Developing guidelines concerning the use of HMWM along with other potential successful sealers.

What We Did

In this research study, a thorough review of previous studies and the current state of practice regarding concrete bridge deck crack sealing was conducted. Case studies were drawn from across the U.S. through a nationwide survey. While focusing on HMWM, the effectiveness of different treatment methods was derived from published literature. Guidelines concerning the use of HMWM and other successful sealants based on the characteristics of sealants, cracks, and bridge decks were developed.

The Life-365 model developed the need to develop under the jurisdiction of the ACI Committee 365 “Service Life Prediction” was employed predict service life. The model has some limitations since a number of assumptions and simplifications have been made to overcome such a complex phenomena or areas where there is insufficient knowledge to permit a more thorough analysis.

Research Results

Cracks, regardless of when they occur, should be sealed as soon as possible (while cracks are not badly contaminated). This will

also ensure that chloride concentration does not reach the corrosion threshold value. For old decks, careful attention should be paid to the preparation method and to the cleanliness of both deck surface and cracks. A range of application temperature between 7 and 29 ^{o}C is recommended. For decks not subjected to deicing chemicals or chloride-laden environments, the use of HMWM as crack sealers can help restore portion of the structural bond strength and the flexural strength only if cracks are narrow and contaminant free. HMWM can be used as surface and crack sealer and is recommended to be applied as early as 3 to 6 months after construction. HMWM is applied to seal cracks as narrow as 0.05 mm and as wide as 12.7 mm. Further evaluation of the effectiveness of HMWM in sealing wide range of crack widths is recommended.

Parametric case studies were conducted to evaluate the effectiveness of HMWM. The study parameters in these case studies include: the concrete deck thickness, concrete cover thickness, water-cement ratio, fly ash percentage, type and percentage of the deck reinforcing steel, bridge location, type of exposure, and protection technique. Table 1 presents the study parameters and the values used in the analyses.

Table 1. Case Study Parameters

Parameter	Symbol	Values
Water-cement ratio (Ratio)	*w/c*	0.4 and 0.5
Bridge location Exposure type		San Diego and Sacramento, California
Protection technique		None, sealer and membrane

The analyses showed the average initiation period for concrete bridge decks located in Sacramento is nearly two and half times that for San Diego concrete bridge decks, while the average initiation period for Fresno bridge decks was nearly 3 times that of San Diego concrete bridge decks. Note that the chloride exposure in the San Diego area is much more severe compared to that in both Sacramento and Fresno.

Increasing the water-cement ratio from 0.4 to 0.5 resulted in reducing the initiation period by an average of 15%. Adding the sealer to concrete bridge decks increased the initiation period by nearly 8%, while adding membrane resulted in an increase with an average of 32%.

The effect of applying concrete deck protection on the initiation period is based on the bridge location and exposure type. The results show that the effect of sealers added to concrete bridge decks in Fresno was negligible due to the low chloride content, while it was significant in San Diego because of the higher chloride content. However, the effect of using sealers (for example, HMWM) on structural bond at crack surface needs to be investigated.

Selected Sample References

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4. Sprinkel, M. M. (1991). *Evaluation of the Use of High Molecular Weight Methacrylate Monomers to Seal Cracks on I-81 over the New River*, Report No. FHWA/VA 91-R19, Federal Highway Administration, Washington, D.C.

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