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Research at a Glance

Technical Brief

Innovative Pothole Repair Materials and Techniques Volume II: Concrete Structure

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Research Problem Statement

Concrete structure are prone to deterioration over long periods of time due to vehicular loadings and external weathering actions. Micro-cracks can develop in concrete that can lead to further deterioration due to chloride infiltration. Infiltration of chlorides into concrete bridge decks can accelerate the corrosion of the reinforcing steel or steel girders underneath. Since the volume of corroded products is generally higher than parent metal, corroded reinforcement can further accelerate the cracking of concrete and cause delamination which will eventually lead to spalling and potholes. The exponential nature of the material degradation may eventually require replacement of the bridge deck. Moreover, potholes on the concrete pavements over bridge decks can cause additional safety concerns for the riders. Hence, long lasting repair of damaged pavements is a primary concern for the owner of the roadway or bridge.

A good repair material thus becomes necessary for maintaining the concrete bridge decks and pavements. Additionally, since the repair of such damage on the pavements requires a temporary lane closure, it is desired to have the repair material functional within a few hours of application. This is especially necessary for cementitious patching materials. An ideal repair material should thus have the following characteristics: constructible – the material should be easy to work with and apply under different weather conditions; fast setting – the cementitious patching materials should be able to develop the necessary strength within a few hours of application to minimize lane closure.; long-lasting – the repair material shall possess good durability to serve the purpose of preventing further deterioration of the pavement. For cementitious patch repair materials, the durability is ensured by preventing the shrinkage cracks, and enhancing the flexural behavior and toughness; and compatibility with the parent concrete – the repair material shall stay adhered to the parent concrete in the presence of environmental stressors and vehicular loads.

Research Objectives

The primary objectives of the investigation are 1) Developing rapid setting patch repair materials for overhead, vertical, and horizontal concrete repair pertaining to the requirements of NJDOT; 2) Evaluating the developed mix formulations based on workability, compressive strength, and flexural strength gain in 3 and 24 hours; 3) Evaluating the load-deflection response of the flexural specimens; and 4) Evaluating the developed patch repair materials for long-term durability by monitoring cracking formation and crack width from restrained shrinkage tests.

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Methodology

Based on extensive literature search and several DOT practices, three formulations were chosen as the best performing candidates. All three formulations are listed on the NJDOT QPL. The three formulations were further improved to increase workability especially for pumping, better toughness, and better adhesion to eliminate the need for the bedding compound. The workability was improved using the polymer whereas the toughness using nonmetallic fibers. One formulation has a stronger adhesion which could be used where adhesion is a primary requirement. Typically, the repair mortar has a lower shrinkage strains. An attempt was made to further decrease the shrinkage strains by adding fine aggregates. Workability, strength, and restrained shrinkage cracking of the formulations were investigated The restraint shrinkage test protocol simulated upper and lower limits of restraint that a repair material undergoes in real applications. The repairs were also cast and placed in external environmental conditions to expose them to natural weathering actions. The cracking behavior was evaluated including cracking spacing and maximum crack width

Results

Long lasting and durable repair materials are necessary for maintaining concrete pavements, concrete bridge decks, and substructure to prevent deterioration and ensure longer service life. Rapid setting cementitious patch repair materials are popular for repairing small concrete damages and providing a functional repair within few hours.

The investigation led to the identification of three formulations that did not crack for a period of 10 months in filed exposure to NJ climate conditions. Typically, rapid set formulations do not shrink after 6 months. The formulations that did crack revealed that addition of 1 percent of PVA fibers could significantly reduce the maximum crack width. The maximum crack widths observed in all the formulations were an order of magnitude less than the maximum allowable crack width specified by NJDOT which is 1/32 in. Use of Schmidt hammer for non-destructive compression testing of rapid setting class of materials was evaluated so it can be used as quality assurance tool before openings lanes to traffic. The research effort did lead to the identifications of the formulations for horizontal, vertical, and overhead rapid repairs and elimination of the bedding compound. The Schmidt hammer can be used to ascertain that the needed compressive strength was achieved.

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