Research Summary

Construction & Materials Best Practice for Concrete Sidewalks

Research Need

Rapid deterioration of concrete sidewalks has been observed after only a few cycles of freezing and thawing. The causes for this rapid deterioration are not fully known but are believed to be caused by a combination of effects including materials, concrete mixtures, and construction practices.

Goals/Objectives

This project seeks to accomplish the following objectives:

1. Determine best construction practices that result in durable concrete sidewalks. Best practices include activities during concrete fabrication and placement, finishing procedures and time to initiate finishing operations, and curing method and duration (moist cure, chemical cure, no cure).

2. Identify the best performing concrete mix design formulation that contributes to freeze-thaw durability.

3. Identify effects that deicing chemicals might have when used for winter treatment of concrete sidewalks.

4. Identify the factors that contribute to surface scaling of concrete sidewalks through a combination of laboratory testing of hardened concrete (scaling resistance, petrographic analysis, air void structure analysis, and chloride content) and photographic documentation conducted at the site.

Methodology

This collaborative project involves industry (contractors, concrete suppliers), academia, and MassDOT personnel. Concrete sidewalks constructed using six different concrete mixtures were placed at the MassDOT Research and Materials Laboratory in Hopkinton, MA. Different sidewalk panels were cast using two different finishing practices and three different curing methods, and were subjected to two different winter treatment methods. Concrete samples were obtained during sidewalk placement to determine the scaling resistance of each concrete mix and to subject hardened concrete cylinders to petrographic analysis and air void structure analysis. Petrographic analysis, air void structure determination, and chloride ingress analysis were also performed in sixty concrete cores taken from the sidewalk panels after the first winter season. These analyses were complemented by photogrammetric analyses of pictures taken periodically of the sidewalk panels at the site.

Key Findings

The study resulted in the following findings:

1. Surface scaling tests conducted in accordance with ASTM C672 did not correlate directly with field observations, although testing was able to identify best performing concrete mixtures.

2. Following cold weather concreting practices in accordance with the American Concrete Institute guidelines (ACI 306) is essential to avoid surface scaling damage of sidewalks subjected to the rigors of winter treatment and freeze-thaw cycling.

3. Quality control during all phases of mixture design, fabrication, construction, and maintenance is fundamental to control the tendency of concrete sidewalks to scale after being subjected to only a few freeze-thaw cycles. Concrete curing that strictly complies with cold weather concreting techniques should be followed to decrease susceptibility of surface scaling.

4. Photogrammetry can be used to reliably quantify surface scaling, thereby eliminating the subjectivity associated with percentage of surface scaling.

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Use of Findings

This project addressed several issues associated with surface scaling of concrete sidewalks. The findings can be used to:

1. Develop best practices in the construction and maintenance of concrete sidewalks to increase their freeze-thaw durability by mitigating surface scaling. The best practices are intended to translate in lower maintenance and replacement costs.

2. Develop a standard specification for the construction and maintenance of concrete sidewalks subjected to freeze-thaw cycles and winter treatment operations to prevent surface scaling in the short term.

Project Information

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