

## ABSTRACT

Todd, Nathan T. M.S.C.E., Purdue University, December 2015. Assessing Risk Reduction of High Early Strength Concrete Mixtures. Major Professor: W. Jason Weiss.

Overnight concrete pavement patching has become a common method of rapid roadway rehabilitation utilized by the Indiana Department of Transportation (INDOT) and other transportation agencies. However, tight construction schedules cause for increased risk to contractors attempting to meet specifications for traffic opening; causing increased bid prices to account for liquidated damages. This work looks to reduce the risk of high early strength (HES) concrete patching materials through material examination and behavior under field exposed and simulated conditions. Five site visits to a pavement rehabilitation project on US HWY 30 in northern Indiana were made in order to examine field mixtures and practices. Elevated concrete temperatures and inaccurate maturity predictions due to a reduction in flexural strength development when exposed to high temperatures and accelerator dosages were found to be consistent problems during these site visits. Next, a laboratory program was developed to evaluate an observed crossover strengths in field tested concrete beams using calorimetry and fracture testing. A testing matrix evaluating four different temperatures, 10, 23, 37.5, and 50 °C, and accelerator dosages, 0, 20, 40, 60 oz/ cwt., was implemented for examination using these techniques. The results showed a decrease in the accelerating admixtures effectiveness at high temperatures and a potential sulfate imbalance. Additional SO<sub>3</sub>, in the form of gypsum and plaster, was added to the original mixture as a 1-2% cement replacement by mass, to examine if performance can be improved. Additional sulfate may serve

as a potential solution to behavioral changes under these conditions. Internal curing has been proven to be an effective value added methodology to improving the durability of bridge decks in Indiana. Observation has shown that at four different ICBHPC county bridge decks, internal curing vastly improves the durability, and thus the service life of concrete pavements compared historical bridge deck mixtures. Thus, internal curing could serve as an application to improving the durability, and thus the service life of HES patching techniques. Value added methods of additional sulfate and internal curing could serve to be applied to HES mixtures to improve performance. Improved performance leads to reduced risk while increasing the service life of these repairs, ultimately saving money and time.