ABSTRACT

Todak, Heather N. M.S.C.E., Purdue University, December 2015. Durability Assessments of Concrete using Electrical Properties and Acoustic Emission Testing. Major Professor: W. Jason Weiss.

Premature damage deterioration has been observed in pavement joints throughout the Midwestern region of the United States. Over time, severe joint damage creates a transportation safety concern and the necessary repairs can be an extreme economic burden. The deterioration is due in part to freeze-thaw damage associated with fluid accumulation at the pavement joints. This very preventable problem is an indication that current specifications and construction practices for freeze- thaw durability of concrete are inadequate.

This thesis serves to create a better understanding of moisture ingress, freeze-thaw damage mechanisms, and the effect of variations in mixture properties on freeze-thaw behavior of concrete. The concepts of the nick point degree of saturation, sorptivity rates, and critical degree of saturation are discussed. These factors contribute to service life, defined in this study as the duration of time a concrete element remains below levels of critical saturation which are required for damage development to initiate. A theoretical model and a simple experimental procedure are introduced which help determine the nick point for a series of

32 concrete mixtures with unique mixture proportions and air entrainment properties. This simple experimental procedure is also presented as a method to measure important electrical properties in order to establish the formation factor, a valuable measure of concrete transport properties.

The results of freeze-thaw testing with acoustic emission monitoring are presented to help understand and quantify damage development in concrete specimens when conditioned to various degrees of saturation. This procedure was used to study the relationship between air entrainment properties and the critical degree of saturation. Applying the concepts of degree of saturation and sorptivity, a performance-based model is proposed as a new approach to specifications for freeze-thaw durability. Finally, a conceptual model is presented to illustrate the effect of various changes in mixture proportions and air void properties on service life.