ABSTRACT

Thomas, D'Shawn. M.S.C.E., Purdue University, May 2016. Assessing The Performance of a Soy Methyl Ester –Polystyrene Topical Treatment to Extend the Service Life of Concrete Structures. Major Professor: W. Jason Weiss.

Concrete is the single most widely used material in the construction industry. In ideal environments, concrete materials are inherently durable and have long service lives. However, a variety of issues such as poor maintenance and construction practices, can result in less than ideal performance resulting in degradation. The degradation of concrete elements can take many forms such as erosion, corrosion, cracking and chemical reactions. Surface applied topical treatments have demonstrated the ability to extend the service life of concrete structures. However, many topical treatments are not always eco-friendly and economical. Experimental results show that Soy Methyl Ester (SME), a derivative of soy bean oil, along with the incorporation of polystyrene (PS) is a non-toxic, biodegradable, and renewable material that can be used effectivity as a topical treatment [9,10]. However, a need exists to quantify the performance of SME-PS blends over longer periods of times and to determine how SME-PS changes chloride ingress and damage.

This thesis expands upon previous research in exploring the use of SME-PS blends as a topical treatment used to enhance concrete durability [9, 10, 12]. The objectives of this study were to quantity the performance of SME-PS blends overtime and to investigate how SME-PS changes chloride ingress and damage. To achieve these objectives, 60 concrete slabs made according to Indiana Department of Transportation (INDOT) specifications as well as several other variations were cast at the Center for Aging Infrastructure (CAI). In the experimental investigation, concrete slabs with different mixture proportions were topically treated with SME-PS and sprayed with NaCl, $MgCl_2$ and $CaCl_2$ solutions with a mass concentration of 10% to accelerate chloride ingress. Continuing acquisition of cored specimens from the CAI site will help researchers understand when reapplication is recommended. After initial salt exposure, cores were extracted from representative pavement sections. To evaluate the samples, chloride concentration profiles were obtained from titrating grinded powder samples. The surface

chloride concentration (Cs) and diffusion coefficient (Dapp) are measured at different material ages by fitting acid soluble chloride concentration profiles to Fick's second law of diffusion.

Statistical analysis was employed using Fick's second law of diffusion to refit chloride concentration profiles obtained from SME-PS treated specimens with 50% to 60% of the Cs values obtained from plain control samples to determine the effects of SME-PS on Dapp. The estimated values of 50-60% were chosen for Cs, for the reason that it was shown experimental that when SME-PS is present, Cs decreased by as much as 45-70%, regardless of the type of salt used. The experimental results indicate Dapp does not change significantly in the presence of SME-PS, which indicates SME-PS blends change chloride binding. This impacts the total chloride concentration in cementitious systems. Since, Cs changes significantly and Dapp does not widely change in the presence of SME-PS, this specifies the chloride in the pore solution is not drastically effected. The laboratory investigation phase of the study included a continuation of previous studies in understanding and quantifying both the short and long term durability of SME-PS blends through non-destructive testing methods such as water absorption and chloride penetration test by ponding.