Kansas Department of Transportation

TECHNICAL SUMMARY

Do Polyepoxy/Polyisocyanate Composite Resins for Concrete Protection Perform Better Than Either of Their Components?

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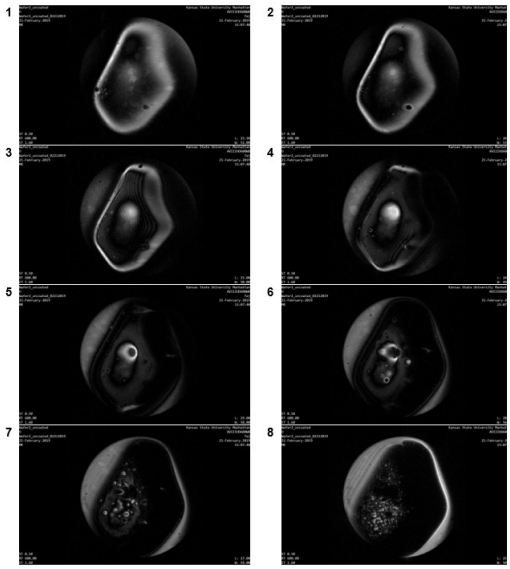

Magnetic resonance imaging of a Type 2 concrete wafer

Introduction

Polyepoxy and polyisocyanate resins are currently in use for protecting concrete and especially steel structural elements in concrete from water-induced corrosive processes. The newest class of materials consists of polyepoxy/polyisocyanate composite resins. The underlying paradigm of using these composite materials is that they show structural synergy, leading to improved material properties, such as improved adhesion to concrete surfaces and higher durability, resilience, and weather resistance.

Project Description

The first phase of this research project consisted of the synthesis and chemical characterization of the required polyisocyanate resins and polyepoxy/amine resins. These resins are required, because their interaction with each other when adsorbed on concrete will be studied in Phase 2. The research team then investigated the chemical interaction between the model resins that were optimized in the first phase of this project in Phase 2. The thermal stabilities of the resulting composite materials were studied to estimate their resistance against weathering. Researchers could observe enhanced stability of polyisocyanate/polyepoxy/amine co-resins at very broad mixing ratios (5:95 to 95:5 weight ratios), with a maximum of thermal stability at 75:25 polyisocyanate to polyepoxy resin precursors. The observed increase in thermal stability was attributed to the formation of urea-type bonds between isocyanates and amines. This reaction can only occur if the resin precursors for

polyisocyanates and polyepoxy/amines are mixed. This formation of novel bonds has been corroborated by nuclear magnetic resonance (^{1}H-NMR) spectroscopy. The third phase of this research project consisted of the atomic force microscopy (AFM) and magnetic resonance imaging (MRI) of two types of wafers that were provided by KDOT, as well as coated wafers. The final phase of this research project consisted of MRI of optimized polyepoxyamine resin (B) on the surfaces of Type 2 concrete model wafers provided by KDOT.

Project Results

FLASH, RARE, and Turbo-RARE imaging clearly demonstrated that polyepoxyamine resin (B) is a very suitable polymer coating for Type 2 concrete wafers. This proves that ultra-high-field MRI imaging is an excellent method for imaging polymer-concrete interfaces. The results clearly demonstrate that polyepoxyamine resins are, principally, superior as protective concrete coatings to polyurethane coatings, which were found not to be strongly adhesive. Mixtures of polyepoxyamine and polyurethane resins were dominated by their polyurethane content and, therefore, not as suitable as pure polyepoxyamine resins.

Project Information

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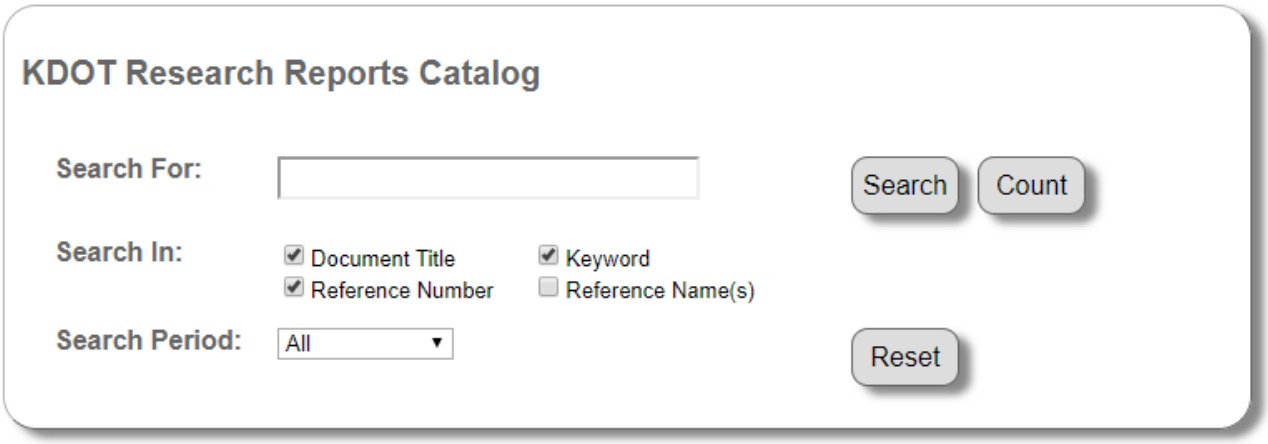

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