CIAMTIS REU

Project 1

Bonding of Overlays to Ultra-High-Performance Concrete

Mentor: Dr. Jovan Tatar

Overview: Ultra-high performance concrete (UHPC) has strength and durability that far exceed those of conventional concrete. This has led to implementation of UHPC in the new generation of bridges, improving bridges' safety and longevity. Overlay materials (such and polyester polymer concrete and latex-modified concrete) are used over UHPC on bridge decks to provide a smooth riding surface and prevent infiltration of water and deicing chemicals. However, not much is known about the bond between overlays and UHPC. Since poor overlay bonding to UHPC can result in significant maintenance costs, this research investigates the influence of overlay type and UHPC surface preparation on the bond quality. The overarching goal of the project is to create construction specifications based on the findings from this work for direct implementation by the Delaware Department of Transportation and other transportation agencies.

Suggested Coursework: Construction Materials, Construction Materials Lab, Mechanics of Materials, Mechanics of Materials Lab. Equivalent courses are acceptable.

Project 2

Extending the Service Life of Rigid Pavement Joints with Self-Healing Sealants

Mentor: Dr. Jovan Tatar

Overview: This project will address the problem of relatively poor long-term performance of sealants in rigid pavements by introducing polymer networks with dynamic covalent bonds, which will enable self-healing of sealants. Research on vitrimers—polymers with dynamic covalent bonds that are thermally stimulated—has grown over the past decade due to their ability to repeatedly repair damage. Work on this project is aimed at furthering the understanding of relationships between the sealant's structure and its physical, mechanical, and self-healing properties. The project also investigates the effect of environmental exposure on sealants' structure-property relationships. Mechanical testing, microscopy, spectroscopy, and thermal analysis will be used to determine the effect of moisture, elevated temperature, and UV radiation on the dynamic polymer network, understand aging mechanisms, and how changes on the molecular level relate to self-healing efficiency.

Suggested Coursework: Construction Materials, Construction Materials Lab, Mechanics of Materials, Mechanics of Materials Lab. Equivalent courses are acceptable.

CIAMTIS REU

Project 3

Improving the Performance of Externally Bonded Carbon Fiber Reinforced Polymer Composite Repairs in Concrete Structures with Fiber Splay Anchors

Mentor: Dr. Jovan Tatar

Overview: Over 7.5% of national bridges are in poor condition, many of them being concrete bridge. Thus, a reliable strengthening technique, such as anchored externally bonded CFRP, has potential to rapidly address some of the deficient bridge inventory. The objectives of the research are twofold: (1) to develop a test method for quantifying the effectiveness of fiber splay anchors for externally bonded CFRP reinforcement; and (2) to elucidate the effect of anchor design variables on the performance improvement of externally bonded CFRP. This research is expected to greatly impact the development of American Concrete Institute (ACI) design guidelines for implementation in the design practice.

Suggested Coursework: Structural Analysis, Mechanics of Materials, Mechanics of Materials Lab, Construction Materials, Construction Materials Lab. Equivalent courses are acceptable.

Project 4

Using Consumer Grade Cameras for Bridge Load Testing

Mentor: Dr. Tripp Shenton

Overview: Assessing the safe load carrying capacity of a bridge is an important step in ensuring the safety of the traveling public. Today this can be done by load testing the bridge. And while bridge load testing has become increasingly more common, it is still not widely used because of the specialized equipment and knowledge that is needed to conduct the test. To make bridge testing easier, more economical, and more widely available, we propose to use digital image correlation techniques, using consumer grade cameras (i.e., phone or Go-Pro cameras), to measure the deflections of a bridge under load. This research project will involve a laboratory test of a steel girder in 3-pt bending. The deflection of the girder will be measured using conventional sensors, and video recorded using consumer grade cameras. The video image data will be post-processed to determine the girder deflections and the results compared to the conventional sensor results. If successful, the work will demonstrate that consumer grade cameras can be used with a high degree of accuracy for bridge load testing.

Suggested Coursework: Structural Analysis, Mechanics of Materials, Mechanics of Materials Lab. Equivalent courses are acceptable.

CIAMTIS REU

Project 5

Effective Deployment of UAV Technology for Improved Project Delivery and Enhanced Asset Management

Mentor: Dr. Christopher L. Meehan

Overview: UD researchers have developed a number of innovative workflows for using UAV/drone technology to conduct aerial surveying of the ground surface or other objects. This approach can allow project owners to collect extensive data very rapidly, for significantly improved management of projects and assets over time. Researchers will work closely with interested owners to identify areas where UAV/drone technology can be used to improve project delivery, perform improved construction inspection, and to collect data that can be used to build "digital twins" for completed projects. Example applications of the proposed research include: (1) volumetric analysis of earth moving operations, (2) stockpile management on active construction projects, (3) performing lift thickness control of soil and asphalt compaction, (4) creating "digital twins" of constructed projects for long-term asset management, and (5) surveying of structures over time to assess deformations, as part of an integrated asset management workflow.

Suggested Coursework: CIEG 211: Statics, CISC 106: General Computer Science for Engineers. Equivalent courses are acceptable.

Project 6

Evaluation of Bond Strength of Tack Coat

Mentor: Dr. Haritha Malladi

Overview: An asphalt concrete pavement is constructed in multiple layers. To promote bonding between these layers, a thin layer of liquid—tack coat—is applied between each layer. Tack coats are also used in resurfacing existing asphalt concrete pavements with an overlay. Adequate bonding between pavement layers and especially between the existing road surface and an overlay is critical for the completed pavement structure to behave as a single unit and provide adequate strength. Inadequate bonding leads to delamination (debonding) followed by distresses that greatly reduce pavement life. This project involves working with the Delaware Department of Transportation (DelDOT) to randomly sample cores from newly pavement location and determine the bond strength between the layers. The specific objective is to evaluate what a good end-result bond strength is based on proper application of tack. This research will help DelDOT develop a specification for bond strength for tack coat applications.

Suggested Coursework: Solid Mechanics, Construction Materials, Construction Materials Lab, Probability and Statistics for Engineers. Equivalent courses are acceptable.

CIAMTIS REU

Project 7

Correlation of Balanced Mix Design to Pavement Condition Ratings

Mentor: Dr. Haritha Malladi

Overview: Balanced Mix Design (BMD) is an ongoing effort to ensure performance of asphalt concrete pavements while allowing for optimization of costs and encouraging innovation. BMD is defined as “asphalt mix design using performance tests on appropriately conditioned specimens that address multiple modes of distress taking into consideration mix aging, traffic, climate and location within the pavement structure” per AASHTO PP 105-20. The goal of BMD is to use laboratory tests to accurately predict the performance in the field and help contractors use the right mix for the job. This research project involves linking BMD standards to performance of the mixtures in the field. The specific objective is to find a correlation between laboratory tests on asphalt mixtures and pavement condition ratings. Long term, this research will help the Delaware Department of Transportation (DelDOT) determine the focus of testing and predict the performance of asphalt pavements.

Suggested Coursework: Solid Mechanics, Construction Materials, Construction Materials Lab, Probability and Statistics for Engineers. Equivalent courses are acceptable.