CIAMTIS REU Project Descriptions

Recyclability of Composite Materials Derived from Renewable Resources

Mentor: Dr. Jovan Tatar

Overview: Fiber-reinforced polymer (FRP) composites have become an essential and widely used construction material. While FRP composites offer significant advantages over concrete and steel—such as higher strength-to-weight ratio, improved durability and faster construction—these materials are produced from non-renewable fossil fuel feedstocks with a substantial carbon footprint. This research examines novel recyclable composite materials manufactured from renewable sources, like natural fibers and biomass-derived epoxy. The specific objective is to investigate the recyclability potential of composites consisting of flax fibers and epoxy resin with reversible covalent bonds. The project employs sensitive materials characterization techniques and mechanical testing of to elucidate the effects of recycling on the material properties.

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

Use of Photo Recognition Tools to Reduce Subjectivity in Bridge Inspection

Mentor: Dr. Jennifer McConnell

Overview: Bi-annual bridge inspections are federally mandated for nearly all bridges in the United States. This represents a significant expenditure of labor and equipment resources. Yet, the information generated during these inspections is largely based on visual assessments that are qualitative and subjective. A recently completed pilot study explored the use of artificial intelligence to quantify the percent of rusting and paint loss on deteriorated painted steel laboratory specimens, similar to real-world corrosion of bridges, and yielded promising results. The project will build on existing successes to transition the laboratory-proven techniques to the field. Real-world bridge inspections will be shadowed with trained inspectors performing traditional inspections and researchers performing inspections using photography and AI. The results will be compared to assess the potential of the innovative method and to provide best practices for the use of photography in this application by considering variables such as scale, lighting, and color correction.

Suggested Coursework: Introductory computer programming

Assessment of Saltwater Intrusion in Coastal Infrastructure

Mentor: Dr. Jennifer McConnell

Overview: Sea level rise has the potential to greatly increase the volume and rate of saltwater intrusion in natural and built systems. One specific concern caused by this is saltwater intrusion in concrete infrastructure, which can cause premature and / or unexpected corrosion and structural failures. This is a particular concern in Delaware, which has the 4th highest coast-to-area ratio in the United States, but also affects the 40% of the US population that lives along a coastline. The project will consider causes and / or effects of sea level rise and saltwater intrusion. Possible avenues of research include quantification of the airborne and groundwater salinity in different locations, sampling of concrete near the coastline to assess the depth to which chlorides have been absorbed in concrete members, and investigation of concrete mix designs that are more resistant to chloride permeation.

Suggested Coursework: Civil engineering materials, chemistry

An Investigation into Fracturing of Asphalt Pavement Surfaces Using Tillage Radishes

Mentor: Dr. Haritha Malladi

Overview: The United States has large tracts of unused impervious surfaces that are paved with asphalt including old subdivisions, parking lots, and disused roads. The paved surfaces exacerbate the urban heat island effect, impair water percolation, and cause detrimental effects from rapid temperature fluctuations in nearby streams. Due to the lack of economic incentives to mill up these paved surfaces, they generally lay abandoned, sometimes for decades. Tillage radishes, which have been used in agriculture to relieve soil compaction, could be used to unseal soils beneath pavements. This study involves performing a Life Cycle Assessment (LCA) to quantify the inputs required to achieve pavement fracturing and removal using tillage radishes. LCA results will be compared with achieving similar results with industrial equipment. The study scope may also include experimental research into the mechanics of pavement fracture using tillage radishes.

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