**PhD Research Seminar Talk- II**

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**Title: Influence of sustainable fiber treatment on fracture behavior and life cycle assessment of hybrid banana-sisal fiber reinforced bio-composite**

**Abstract:**

The increasing demand for sustainable composite materials has intensified the interest in natural-fiber-reinforced bio-based polymer systems and serves as potential alternatives to conventional glass-fiber-reinforced epoxy composites. In the present study, previously established optimum bio-acetic acid treatment with 6% concentration was selected for treating the reinforced fibers. Here, along with banana fibers, sisal fiber in short form is also incorporated to investigate its fracture behaviour under different loading and environmental conditions. Mode I tensile-opening and Mode II in-plane shear fracture behaviour were experimentally evaluated using a modified Arcan fixture setup. The specimens were tested for crack-length-to-width ratios (a/W) of 0.1 and 0.3 under both dry and wet conditions. The wet specimens were conditioned using deionized water prior to fracture testing to assess the influence of moisture on crack initiation, propagation and fiber–matrix interfacial behaviour. The experimental observations provide insight into the effects of crack length and moisture exposure on load-bearing capacity and fracture resistance. In addition, Mode I interlaminar fracture toughness of the dry composite was investigated using the Double Cantilever Beam (DCB) test, enabling assessment of resistance to interlaminar crack initiation and propagation.

To complement the mechanical assessment, life-cycle assessment (LCA) was performed to quantify and compare the environmental impacts of the developed bio-composite systems with conventional glass-fiber-reinforced epoxy laminates. The investigated configurations included bio-acetic bio-laminate, acetic bio-laminate, NaOH bio-laminate, bio-acetic laminate, acetic laminate, NaOH laminate and glass-fiber laminate. The LCA framework considers the environmental implications associated with material processing and composite production, providing a comparative basis for evaluating the sustainability of bio-epoxy-based natural-fiber composites. The combined fracture-mechanics and LCA approach establishes a comprehensive basis for assessing the mechanical performance and environmental viability of natural fiber reinforced bio-epoxy composites for sustainable structural applications.