Department of Mechanical and Aerospace Engineering
Indian Institute of Technology Hyderabad
Kandi - 502285, Sangareddy, Telangana, India

MAE Seminar Series | Lecture 6

Title:	Ultra-lightweight Carbon Fiber Reinforced Thermoplastic Composite Door Assembly
Speaker:	Dr. Shridhar Yarlagadda, Associate Director for Research at the University of Delaware Center for Composite Materials
Affiliation:	University of Delaware Center for Composite Materials, Newark, Delaware, United States.

Abstract | Developing and adopting new and innovative materials has seen a major uptick due to several factors, from lightweighting to sustainability. However, a major roadblock to adopting these materials is the conventional automotive product development process rooted in costs, risk mitigation, catastrophic failure, and the lack of expertise at the systems and design level. New materials like carbon fiber-reinforced thermoplastic composites offer high stiffness, strength, lightweight, and re-processability while having short cycle times. However, their adoption is severely limited by complex material architecture (localized stiffness properties), the inability to predict manufacturing defects, and model composite failure behavior. These challenges form the centerpiece of our project, whose goal was to reduce the weight of a driver's side door for a mid-size SUV by 42.5%, all while adhering to strict functional requirements while capping cost at $5 per pound of weight reduced. This initiative, funded by the Department of Energy-Vehicle Technologies Office and Honda Development and Manufacturing of America, LLC, used carbon fiber reinforced thermoplastic (CFRTP) composites design that utilized Nylon-based woven continuous carbon fiber laminates. The team employed a system engineering approach to leverage part consolidation and the power of modern structural optimization tools to develop a design that reduced the number of structural parts to be manufactured and assembled by half (52 %). Finite Element Analysis (FEA) based optimization strategies enabled the team to use only two lightweight CFRTP panels and a few steel and aluminum sheet-metal parts for

locally improved strength and toughness. This presentation delves into the details of FEA and the development of a novel manufacturing-to-response (MTR) pathway to systematically understand the effects of manufacturing process parameters at different length scales and develop predictive models to accurately determine micro- and macro-mechanical properties to meet federal crash safety standards. Lastly, this work highlights the performance of the CFRTP door prototype and its performance compared to the baseline steel door.

About the Speaker | Dr. Shridhar Yarlagadda is the Associate Director for Research at the University of Delaware Center for Composite Materials and holds a Ph.D. in Aerospace Engineering from Penn State. Dr. Yarlagadda has been conducting research in materials, processing, and manufacturing of composite materials and structures for over 25 years. He is a co-inventor of the highly aligned discontinuous Fiber (TuFF) technology and has led research programs across the spectrum of materials, design, manufacturing, and prototyping composite structures. Current projects include customized carbon fiber orthoses, composite structural assemblies for space suits, and high-volume manufacturing technologies for aerospace structures. He has co-authored over 100 articles, including journal and conference papers and patents.

Date: 05/03/2025
Time: 1530-1630 Hrs.