The Department of Mechanical Engineering / College of Engineering and Applied Sciences
Stony Brook University

Mechanical Engineering Seminar
Faculty Candidate

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PhD Candidate
Department of Mechanical Engineering
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Lecture Title: Transverse Impact of Ballistic Fibers, Yarns and Composites – Fiber Length Scale Modeling and Experiments

Monday, April 18, 2016 at 2:00PM, Room 173 Light Engineering Building

Abstract

Maximum ballistic impact performance at a minimum weight is an important criterion in the design of a protective armor system to increase the mobility and survivability of personnel. Designing new advanced protective materials that are light weight and stronger requires fundamental understanding of deformation, failure and energy absorption mechanisms at different length scales and time scales. Ballistic impact onto textile fabrics and composites is a complicated multi-scale problem given the structural hierarchy of the materials, anisotropic material behavior, projectile geometry and impact velocity. This work explains the fundamental deformation and failure mechanisms during ballistic impact onto flexible textile fabrics at the micron length scale. A hybrid computational-experimental systematic approach is adopted to understand the mechanisms and deformation modes of high performance polymer fibers, specifically Kevlar KM2 that is widely used in soft body armor applications. This fiber level study reveals that fibers are subjected to multi-axial stress states including transverse compression, axial tension, axial compression and transverse shear significant enough to cause fibrillation in the fiber during impact. The inelastic behavior of the fiber in the transverse direction to the fiber axis results in an inelastic collision rather than an elastic collision. The fibers within an impacted yarn are found to load non-uniformly, subjected to multi-axial loading and failure is governed by the inelastic transverse behavior and longitudinal shear modulus of the fiber. Additionally, in order to design composite fiber/matrix interface for maximum energy absorption during impact, a modeling methodology of the microdroplet test method is developed for characterizing the traction separation behavior of S-glass/epoxy composite interfaces at the micromechanical length scale.

Biography

Subramani Sockalingam is a PhD candidate in Mechanical Engineering at the University of Delaware Center for Composite Materials (UD-CCM). His research involves studying the transverse impact of ballistic fibers and yarns and characterization of fiber-matrix composite interface at the micromechanical length scale. His current research interests are in the development of advanced materials that are light weight and stronger through a multiscale experimental and computational approach. He has a Bachelor's from Coimbatore Institute of Technology, India and a Master's in Mechanical Engineering from the University of Cincinnati. Additionally he has six years of industrial experience. His combined industrial and academic experience includes multiscale finite element modeling and analysis of composite materials, experimental material characterization, constitutive model development, ballistic impact, design and development of body and vehicle armor, automotive crashworthiness and engineering consulting.

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