Stony Brook University

Department of Civil Engineering

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Dr. Kedar Kirane

Assistant Professor
Department of Mechanical Engineering, Stony Brook University

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ZOOM LINK: Meeting ID: 950 8981 9867; Passcode: 860265
https://stonybrook.zoom.us/j/95089819867?pwd=NzdKQUJXU3J3NFN4VlpBUlp4bDFhUT09

Mechanism Based Modeling of Fracture in Quasibrittle Composites: Challenges, Applications, and Limitations

Abstract

For reliable structural designs involving modern engineering materials such as concrete and composites, an accurate prediction of their failure is crucial. This includes not only prediction of load capacities at the onset of failure in uncracked/pre-cracked/notched structures, but also the energy dissipation by complete structural failure (e.g., automotive crash, missile impact of concrete panels). However, these materials have a highly heterogeneous microstructure. As a result, their failure behavior is highly complicated, multi-scale in nature, and proceeds via multiple damage mechanisms dependent on the loading and boundary conditions. Moreover, the heterogeneous microstructure also makes the fracturing exhibit a distinct quasi-brittle character (neither fully brittle nor fully ductile). This has important implications on structural behavior, especially in terms of size effects in strength and fatigue. This talk reviews the main damage mechanisms in concrete and composites, the ensuing size effects, and the past and ongoing efforts to characterize and predict these behaviors effectively. Special focus will be placed on the semi-multiscale microplane constitutive models. These models clearly distinguish the macro-scale and the micro-scale and allow intuitive formulation of various damage mechanisms at the micro-scale. They also provide a physically sound basis to homogenize the micro-scale damage and predict the macro-scale failure growth and structural size effects. They are thus an effective strategy for multi-mechanism failures in heterogeneous materials. Various successful applications for concrete and composites will be demonstrated followed by a discussion on the challenges in adapting these models to practice.

About the Speaker: Prof. Kedar Kirane is an assistant professor of mechanical engineering at Stony Brook University. His research focuses on characterizing, understanding, and predicting the fracturing and scaling behavior of various conventional and advanced composite materials. These include fiber reinforced composites, polymer nanocomposites, geological and cementitious materials, and soft composites. His research combines experimental, computational, and theoretical approaches. The overarching goal is to develop reliable predictive capabilities and sound scientific bases for safe structural designs in engineering applications. Dr. Kirane obtained his Ph.D. degree from Northwestern Univ., his M.S. degree from the Ohio State Univ. and his B.S degree from the Univ. of Pune, India, all in mechanical engineering. Prior to joining SBU, Dr. Kirane worked in industry, as a finite element analyst at Goodyear Tire & Rubber Co and later as a senior research engineer at ExxonMobil Corp. His research is supported by DOD ARO, DOD ONR, and ASME. He is the recipient of the 2020 Orr Early Career Award by ASME's Materials Division, the 2019 DOD ARO Young Investigator Award, and the 2018 Haythornthwaite Research Initiation Grant by ASME's Applied Mechanics Division.