April 19, 2024

Localization Limiter for Stochastic Simulations of Quasibrittle Fracture

Jia-Liang Le

James L. Record Professor & Associate Department Head, Department of Civil, Environmental, and Geo-Engineering, University of Minnesota

Seminar Details

Friday, April 19, 2024
2:30pm – 4:00pm

UH Campus
Science Building
Room S105

Online via Teams
https://www.cive.uh.edu/research/beyer-distinguished-lecture

ABSTRACT

Continuum finite element (FE) modeling of damage and failure of quasibrittle structures suffers from the spurious mesh sensitivity due to strain localization. This issue has been investigated extensively for deterministic analysis through the development of localization limiters. This talk will present a mechanism-based model to mitigate the mesh sensitivity in stochastic FE simulations of quasibrittle fracture. The present model is formulated within the framework of continuum damage mechanics, and the spatial randomness of material properties is represented by homogenous random fields. Two localization parameters are introduced to describe the evolution of the damage pattern of finite elements. These parameters are used to guide the energy regularization of the constitutive law, as well as to determine the mapping of the random fields of material properties onto the finite element mesh. The model is applied to simulate the stochastic failure of quasibrittle structures of different geometries featuring different behaviors including both distributed and localized damage. It is shown that the existing local projection and local averaging mapping methods could lead to strong mesh dependence of the predicted mean and variance of the structural load capacity. To mitigate the spurious mesh sensitivity, the mapping of the random fields of material properties must be tied to the damage pattern, which may evolve during the loading process. This result has important implications for the recent trends in the machine-learning approach for constitutive modeling of quasibrittle materials.

BIOGRAPHY

Dr. Jia-Liang Le is the James L. Record Professor and Associate Head of the Department of Civil, Environmental, and Geo- Engineering at the University of Minnesota. He received his Bachelor of Engineering (First Class Honors) and Master of Engineering in Civil Engineering from the National University of Singapore, and a Ph.D. in Structural Engineering and Mechanics from Northwestern University. He is a registered Professional Engineer in Minnesota. He is a fellow of ASCE Engineering Mechanics Institute, and a member of Board of Directors of IA-Framcos. His research interests include fracture mechanics, probabilistic mechanics, scaling, computational mechanics, structural stability, and structural reliability. He received several research awards including the Army Research Office Young Investigator Award, the EMI Leonardo da Vinci Award from ASCE, the Society of Engineering Science Young Investigator Medal, and the Early Achievement Research Award from the International Association for Structural Safety and Reliability (IASSAR).