Structural Engineering Seminar Series

CEE 595 S

Localization Limiter for Stochastic Simulations of Quasibrittle Fracture

Jia-Liang Le

Department of Civil, Environmental, and Geo- Engineering
University of Minnesota

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 interest is placed on the analysis of large-size structures, where the mesh size is conveniently chosen to be larger than the width of the fracture process zone as well as the correlation lengths of the random fields of material properties. The present model is formulated within the framework of continuum damage mechanics. 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 formulate the mesh-dependent probability distribution functions of constitutive properties. The model is applied to simulate the stochastic failure behaviors of quasibrittle structures of different geometries featuring different failure processes including both distributed and localized damage. It is shown that using fixed probability distribution functions of constitutive properties could lead to strong mesh dependence of the predicted mean and variance of the structural load capacity. To mitigate the spurious mesh sensitivity, one would need to consider the fact that the probability distribution functions of constitutive properties of the finite element are intimately related to the damage pattern, which may evolve during the loading process. The extension of the model to random field representations of material properties will also be discussed.

Bio:

Dr. Jia-Liang Le is 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 from Northwestern University. He is a registered Professional Engineer in Minnesota. His research interests include fracture mechanics, probabilistic mechanics, scaling, computational mechanics, and structural reliability. He published two books and over 80 journal papers. 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).

Monday, April 10th, 2023 4:00 – 5:20 p.m.

1310 Yeh Student Center