THE UNIVERSITY OF HONG KONG

DEPARTMENT OF CIVIL ENGINEERING

SEMINAR

Elastoplastic Damage Model and Numerical Implementation of Nano-Silica Incorporated Concrete

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Time: 5:00 pm – 6:00 pm
Venue: Room 612B, 6/F Haking Wong Building, The University of Hong Kong

Abstract
An energy-based isotropic elastoplastic damage model is developed for investigating the elastoplastic damage responses and stress-strain relationships of nano-silica incorporated concrete. The formulation employs a multiscale micromechanical framework to determine the effective elastic properties of composites at different scales. The stress-strain constitutive relation is derived by splitting the strain tensor into "elastic-damage" and "plastic-damage" parts while introducing the homogenized free potential energy function and the undamaged potential energy function. The elastoplastic damage response of the material is further characterized by elastic-plastic-damage coupling. To construct realistic 3D three-phase concrete mesostructures in numerical simulations, this paper introduces an encapsulation placement method that avoids particle overlap checking when placing aggregates. This methodology allows adjustments for the aggregate compactness as needed and enhances computational efficiency in concrete mesostructure construction. The numerical results of the modeling show good agreement with the experimental values in the open literature. Further, the influence of nano-silica addition contents and ITZ (interfacial transition zone) thicknesses on the elastoplastic damage response of nano-silica incorporated concrete are quantitatively and qualitatively investigated for the optimization of nano-silica incorporated cementitious composites. The proposed model facilitates simulating and optimizing the mechanical characteristics of nano-silica incorporated concrete and enhances the computational efficiency of 3D concrete modeling with the introduced encapsulation placement method.

About the Speaker
Professor Jiann-Wen Woody JU received his M.S. and Ph.D. degrees from the UC Berkeley. He is a senior tenured Full Professor at **UCLA**, and served as the Department Chair of Civil and Environmental Engineering. Prof. Ju served as an Associate Editor for the ASME *Journal of Engineering Materials & Technology*, and for the ASME *Journal of Applied Mechanics* from 1995 to 2002. He is currently the **Editor-in-Chief** of the *International Journal of Damage Mechanics*, an Associate Editor of the ASCE *J. of Nanomechanics and Micromechanics*, and an Editorial Board member of the *Acta Mechanica*. He served as the ACI 446 Committee Chair. Prof. Ju received the 1991 *Presidential Young Investigator Award* from NSF and White House, 1991 *Alfred Rheinstein Faculty Award* from Princeton Univ., 1997 ASCE *Walter Huber Civil Engineering Research Award*, 1998 ASME Fellow Award, 2000 *ACI-James-Instruments Award* in NDE, 2006 ASCE Fellow Award, 2007 USACM Fellow Award, 2008 ACI Fellow Award, 2008-2009 Invited Chair Professor from University of Paris VI and ENS Cachan (France), 2008 Publication Award of

Merit from the Structural Engineers Association, 2009-2012 Chang-Jiang Scholar Chair Professor, 2010 IACM Fellow Award, 2010 Kwang-Hua Chair Professor (Tongji University), 2011-2013 Tongji Univ. Chair Professor, National 1000 Talents Program (Short-Term) Distinguished Chair Professor (2013-2017), Tongji University Distinguished Chair Professor (2013-present), Guangxi University Distinguished Chair Professor (2013-2021), 2013 ICACM Award, Honorary Distinguished University Professor from Southwest Jiaotong University (2015-present), 2018 ICDM-3 Lifetime Achievement Medal, and 2020 EMI Fellow Award, etc. Recently, in March 2024, Prof. Ju was elected as a member (academician) of the European Academy of Sciences and Arts (Division VI). In January 2024, Prof. Ju was honored as an ASCE Life Fellow. Prof. Ju has published more than **215** SCI-indexed scholarly journal papers. Furthermore, Prof. Ju's journal publications have been highly cited by the *Web of Science*; his h-index is over **55,** his i10-index is over **174**, and his citations are more than **13,037** times. His research interests and research projects encompass structural engineering, structural mechanics, computational mechanics, computational damage, healing and fracture mechanics, micromechanics and nanomechanics of composites, multiscale material modeling, finite elements, biomechanics, computational geomechanics and geotechnical engineering, reliability, NDE, service life predictions, durability of concrete and cementitious composites, environmental assessment, risk analysis, multiphase porous flow and transport, and coupled wind-wave-bridge interactions and damage effects, etc.

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