Seismic Assessment of Beam-Column Joints in Existing Concrete Buildings

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About the Speaker:

Dr. Wael M. Hassan is an assistant professor of structural and earthquake engineering at the National Building Research Center in Cairo and a recent visiting assistant professor at The American University in Cairo and lecturer at Santa Clara University in California. Dr. Hassan holds a PhD degree in structural and earthquake engineering from University of California, Berkeley, USA, where he also spent his post-doctoral fellowship. Dr. Hassan's main research interests include numerical and experimental simulation of reinforced concrete structures under the effect of natural and human-induced hazards. In particular, he is interested in developing analytical models for the seismic performance of components such as concrete columns, beam-column joints, SRC columns, coupling beams, and masonry infills. In addition, he is interested in developing seismic hazard mitigation tools such as retrofitting techniques. He is also interested in performance-based nonlinear simulation and design of tall buildings. Dr. Hassan has research and teaching experience at some top schools including University of California, Berkeley, University of California, Irvine, Santa Clara University in USA, and American University in Cairo. Dr. Hassan's practical experience includes leading the practice of advanced nonlinear simulation and performance-based engineering of tall buildings at Skidmore, Owings and Merrill LLP (SOM) in San Francisco, where he is a licensed civil engineer (PE) and structural engineer (SE). Dr. Hassan serves as a member of several code committees such as ACI 318: US Concrete Building Code, ACI 369: Seismic Retrofit, ACI 441: RC Columns, ACI 374: Performance-Based Seismic Design and ASCE 7: Loads on Building Structures, ASCE 41: Seismic Assessment of Existing Buildings. The outcomes of Dr. Hassan's PhD research project at Berkeley, along with other project team members, led the City of Los Angeles to issue a new ordinance in Oct 2015 to enforce retrofitting its 1500 seismically vulnerable concrete buildings. Another significant impact on the profession by Dr. Hassan's research was the adoption of NIST, ATC-78 and SEAOC guidelines in the U.S. of his developed joint shear and axial capacity models for existing building seismic assessment. His shear strength expressions and nonlinear models for joint simulation are also being considered to revise ACI 369 and ASCE 41 standards for seismic assessment.

Abstract:

Older concrete beam-column joints lacking transverse reinforcement (unconfined joints) are susceptible to severe damage possibly contributing to building collapses during strong earthquakes. Lacking joint transverse reinforcement is a common deficiency in buildings constructed prior to developing ductile

details in the 1970s. Tools to predict shear strength and simulate nonlinear behavior of joints with ductile details exist. In addition, many retrofit strategies for existing joints are available; however, tools to assess existing joint capacity are lacking although concerns about their seismic axial failure vulnerability exist. This presentation shows efforts to improve seismic performance understanding of unconfined joints in existing concrete buildings and to develop new tools for strength prediction and nonlinear modeling. It also offers a quantification method for the axial collapse vulnerability of shear-damaged unconfined joints under cyclic loading. Four full-scale, 3D, corner joint sub-assemblages, with slab, were tested under bidirectional cyclic loading varying axial loads. Test results showed the potential for early shear failure of unconfined joints. Two distinct joint failure modes were identified. Axial load effect on shear strength and deformation capacity varies based on failure mode. Tests revealed the inaccuracy of shear strength of existing building guidelines. A new nonlinear macro-model is developed to simulate cyclic performance. Two axial capacity models, two shear capacity models and one bond model designed for unconfined joints were developed. The proposed models correlated well with previous test results. The City of Los Angeles in USA passed a new ordinance in October 2015 enforcing all its 1500 older vulnerable buildings retrofit based on the research project outcomes. The proposed shear and axial capacity models were adopted by NIST, ATC-78 and SEAOSC NDC guidelines in the U.S. for existing building seismic assessment. The shear strength expressions and nonlinear models for joint simulation are currently being considered to revise ACI 369 and ASCE 41 standards for seismic assessment.