Civil & Environmental Engineering

Washington State University

Development of Performance-Based Seismic Retrofit Methodology for Multi-Story Buildings

Structures Faculty Candidate Seminar

Recent earthquakes such as Loma Prieta (1989) and Northridge (1994) in California have highlighted the poor performance of existing buildings. Although building codes have clearly evolved, the problem is still unresolved for older buildings that are code-deficient and were designed prior to the implementation of modern seismic design codes. In this seminar, the development and validation of performance-based seismic retrofit (PBSR) methodology is being presented. Unlike traditional force-based design methods, the PBSR method enables engineers to design and retrofit buildings to explicitly meet the pre-defined performance criteria for different levels of earthquake intensity; and eventually, results in a more efficient and comprehensive method of retrofitting multi-story buildings. The proposed PBSR method was validated numerically through multi-incremental dynamic analysis (MIDA), and experimentally by conducting a series of full-scale tests on a four-story 4,000 sqft soft-story wood-frame building at the outdoor shake table at the University of California-San Diego. The test provided the first-of-its-kind (landmark) dataset for use by researchers and practitioners for retrofitting soft-story wood-frame buildings. The experimental test results showed that the retrofitted building met the designated performance criteria and essentially validated the proposed PBSR method. It should be noted that although the PBSR method was only validated experimentally for the asymmetric soft-story wood-frame building, the method can be used for any type of structure with vertical and horizontal irregularities. Finally, in order to investigate the collapse mechanism of soft-story wood-frame buildings, the un-retrofitted building was subjected to series of ground motion with increasing intensities until it collapsed. These series of tests are the first controlled-collapse tests of a full-size building in the U.S.

Dr. Pouria Bahmani is an Assistant Professor of structural engineering in the Department of Civil, Architectural Engineering, and Construction Management at Milwaukee School of Engineering (MSOE). His research focuses on performance-based engineering, innovative hybrid structural systems and technologies, traditional and innovative mass timber structures, assessment and retrofit of existing structures, sustainable and resilient infrastructure systems, and large-scale dynamic testing. He is currently working on a multi-university collaborative research project funded by the U.S. Department of Housing and Urban Development (HUD) to develop a guideline for designing mass timber multi-family buildings in the U.S. He is also working on innovative energy dissipation devices to control the performance of mid- to high-rise buildings under wind and seismic loads. Dr. Bahmani received his Ph.D. in the field of Structural and Earthquake Engineering from Colorado State University in May 2015 and joined Milwaukee School of Engineering as an Assistant Professor in Fall 2019. During his PhD studies, he developed and validated a performance-based seismic retrofit (PBSR) methodology to retrofit multi-story buildings with horizontal and vertical irregularities. He served as the lead Ph.D. researcher in an NSF funded multi-university-industry project entitled “NEES-Soft: Seismic Risk Reduction for Soft-Story Wood-frame Buildings” that included a series of shake table tests on a full-scale four-story building at NHERI @ UCSD (formerly NEES @ UCSD) and was concluded with a controlled-collapse test. He also collaborated with researchers at Clemson University and Western Michigan University to conduct series of hybrid tests on a three-story wood-frame building at the structural laboratory at NEES at Buffalo. Dr. Bahmani is an expert on performance-based design of buildings subjected to extreme wind and seismic loads. His work on performance-based design and performance-based seismic retrofit has received national and international attention and has been presented in more than 20 conferences and cited more than 200 times in technical articles, books, and building codes. Prior to joining MSOE, he worked as a structural engineer at Magnusson Klemencic Associates (MKA) in Seattle and KPFF Consulting Engineers in Tacoma/Seattle. He has an extensive experience in design and retrofit of structures and was responsible for design of many high-rise buildings under extreme wind and seismic loads. He is a registered professional engineer in the states of California, Washington, Oregon, and Wisconsin and a member of ASCE/SEI, AISC, ACI-Wisconsin, PCI, and ASEE.

Date: March 25, 2022, 11:00 a.m. - 12:00 p.m.

Place: ETRL 101

Zoom link