CE 890 Grad. Seminar: February 2, 2011, 11:30 a.m., Durland 1052

Effect of Vertical Earthquake Ground Motion on Reinforced Concrete Structures

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Earthquake design has conventionally focused on the effect of horizontal ground acceleration as the primary cause of damage and collapse of engineering works, based on the premise that structures are in general over-designed for gravity. The latter approach was also supported by the general observation that vertical peak ground accelerations from field measurements are a fraction of their horizontal counterparts. Two relatively recent factors have pointed towards serious shortcomings in the assumption that vertical motion effects are negligible. These two factors are; (1) the increase in the number of near-source earthquake measurements that indicated that vertical peak accelerations can be as high, or even higher, than horizontal peak values, and (2) the increasing number of observations of damage and collapse that cannot plausibly be attributed to horizontal shaking only.

Since the late 1990's increasing emphasis has been placed on causes of high vertical earthquake motion, and its effect on engineering structures. Analytical evidence of the detrimental effects of vertical ground motion piled up, while more cases of collapse that cannot be attributed to horizontal motion have been archived. Only recently have experimental evidence been obtained to irrefutably confirm that ignoring vertical earthquake ground motion effects may lead to collapse of structures, with the consequential loss of lives and livelihoods. The presentation highlights two testing programs on RC columns where it is conclusively shown that vertical motion leads to high levels of distress that leads to failure. Extensive parametric studies using analytical tools that were calibrated to the test results led to clear identification of the governing parameters. Indicative values of the effect of each parameter on the response of RC structures were also obtained. The work provides the first experimental evidence of the damaging effect of vertical ground motion, and paves the way for inclusion of this very important effect in seismic design.

The vertical motion effects presentation will be preceded by very brief comments on the Chile earthquakes of February 2010; the MAE Center at Illinois team has just published a comprehensive report on the earthquake, available at http://hdl.handle.net/2142/18212.

Short Bio:

Amr Salah Elnashai, Fellow of the United Kingdom Royal Academy of Engineering, is the Head of the Civil and Environmental Engineering Department, and Bill and Elaine Hall Endowed Professor at the University of Illinois at Urbana-Champaign, USA. He was Director of the NSF multi-institution multi-disciplinary Mid-America Earthquake Center (2004-2009). He was also Director of the NSF Network for Earthquake Engineering Simulations (NEES) Facility at Illinois (2002-2009). A graduate of Cairo University, Amr obtained his MSc and PhD from Imperial College, University of London, UK. Before joining the University of Illinois in June 2001, Amr was Professor of Earthquake Engineering and Head of Division at Imperial College (1985-2001). He has been Visiting Professor at the University of Surrey, UK, since 1997. Other visiting professor appointments include the University of Tokyo, the University of Southern California (1990-1995) and the European School for Advanced Studies in Reduction of Seismic Risk, Italy, where he serves on the Board of Directors since its founding in 2000.

He is founder and co-editor of the Journal of Earthquake Engineering and editorial board member of several other journals, a member of the drafting panel of the European design codes, past chair of the UK earthquake engineering association, UK delegate to and past senior Vice-President of the European Association of Earthquake Engineering. He is the winner of the Imperial College Unwin Prize for the best PhD thesis in Civil and Mechanical Engineering (1984), the Oscar Faber Medal for best paper in the Institution of Structural Engineering, and two best paper medals from the International Association of Tall Buildings, Los Angeles.

Amr's technical interests are multi-resolution distributed analytical simulations, network analysis, large-scale hybrid testing and field investigations of the response of complex networks and structures to extreme loads. He has produced more than 250 research publications, including over 120 refereed journal papers, many conference, keynote and prestige lectures (including the Nathan Newmark Distinguished Lecture), research reports, 2 books and several book chapters, magazine articles and earthquake field mission reports. Amr has successfully supervised 39 Doctoral and over 100 Master of Science theses. Amr enjoys scuba diving and holds certificates from the British Sub-Aqua Club and the US Professional Association of Diving Instructors. He also enjoys reading on history, the history of painting and film-making.