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Spatially varying earthquake ground motion and dynamic response of long bridges: assessment from a structural engineering perspective

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Although bridge structures might seem at a first sight as rather linear and simple structural systems, their actual performance under earthquake loading is more complicated than that of ordinary buildings, because bridges have typically an order of magnitude larger overall and cross-sectional dimensions, different energy absorption mechanisms, more significant contribution of higher modes, while they are most commonly crossing non-uniform soil profiles. Notwithstanding the significant research progress made to date which has already shed some light on many bridge engineering problems, the development of a "realistic" earthquake motion scenario is still associated with the highest relative uncertainty compared to maybe all other design and construction aspects. This is even more pronounced in the case of long bridges, where the variation of ground motion among its supports in terms of arrival time, frequency content and amplitude, can strongly affect both the pseudo-static and the dynamic component of the system.

It is the objective of this presentation to discuss the recent findings with respect to the impact of asynchronous (i.e., spatially variable) seismic excitation on the seismic response of long bridges, based on analytical and numerical evidence as well as on the monitored response of specific bridges recently constructed along the new 780km Egnatia highway in northern Greece (a highway consisting of a total 40km of bridges, most of them located in areas of high seismicity and an unfavorable mountainous topography). Emphasis is also given on the monitored response of the 400m cable-stayed Evripos bridge that connects the Evia island to the Greek mainland, during the 1999 Athens earthquake. Despite the long distance from the earthquake source, the simultaneous free-field and on-structure recordings reveal interesting patterns of higher mode excitation and subsequent dynamic behavior that cannot be a-priori predicted using the conventional analytical methods and the existing design code provisions. Based on the above comparative studies, an effort is made to focus on the dynamic response of the entire, interacting soil-structure system under asynchronous excitation and to propose means for assessing in advance the degree of its potential detrimental influence. The presentation concludes with design recommendations and thoughts on further research needs.

Dr. Anastasios Sextos is an Assistant Professor of Information Technologies in Earthquake Engineering at Aristotle University of Thessaloniki in Greece. His main research interests are related to the application of information technologies for the analysis and design of RC structures and bridges, computational earthquake engineering, software development, numerical analysis of complex structures, spatial variability of earthquake ground motion, soil-structure interaction and rehabilitation of historical structures.

Anastasios Sextos received a 5yr Diploma in Civil Engineering in 1997 at Aristotle University, a Masters Degree on Earthquake Engineering and Structural Dynamics at Imperial College London, U.K. in 1998 and a Ph.D. in Bridge Engineering from Aristotle University in 2001. He was appointed as a lecturer at Aristotle University in 2003, and as an Assistant Professor in 2008. He is the author or co-author of approximately 100 scientific publications, from 2003 to present, including 14 peer-reviewed journal papers, 2 book, numerous book chapters and papers in conference proceedings. He is a reviewer for 20 international scientific journals.

Anastasios Sextos is currently a Fulbright visiting scholar at the University of Illinois at Urbana-Champaign.

He has also been a visiting scholar at University California Berkeley (2007). He has received scholarships and fellowships from the Deutscher Akademischer Austausch Dienst (DAAD, Germany), the Engineering and Physical Science Research Council (EPSRC, U.K.), the Bodossaki Foudation (Greece) and the Institution of Public Scholarships of Greece. He is the PI of a FP7, European Union Research Project (www.exchange-ssi.net) on hybrid simulation and soil-structure interaction involving participants from Greece, France, Italy and the U.S. (U.I.U.C.) the latter acting as the hosting institution. Since 2009, he is the General Secretary of the Hellenic Association of Earthquake Engineering (affiliated to the European Association of Earthquake Engineering).

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