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Yi-Lung Mo, J Material Sci Eng 2017, 6:10 (Suppl)
DOI: 10.4172/2169-0022-C1-087

14th International Conference on

ENERGY AND MATERIALS RESEARCH

December 06-07, 2017 Dallas, USA

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Periodic materials for dynamic design of energy infrastructures

Conventional dynamic isolation systems currently under development employ high-damping rubber bearings, lead rubber bearings, or friction pendulum bearings. These systems are effective in reducing the damaging effects of the horizontal components of a dynamic excitation, but they are not well suited for protection against the vertical components of dynamic loads. Current dynamic isolation systems also cause large relative horizontal displacement between the foundation and the supported structure, which occurs during a dynamic excitation event, further complicating the design. A gap is usually provided between the isolated structure and the surrounding non-isolated structures to avoid hammering. A design that eliminates the need for such design restrictions would be very attractive. The proposed technology will attempt to overcome the disadvantages existing in current dynamic isolation systems by developing innovative periodic material-based dynamic isolators. These dynamic isolators, in effect, use the foundation of the infrastructure as the base isolation system. The foundation is made of a new material, called periodic material, which can block, or reflect, the damaging dynamic motion being transmitted to the infrastructure. Guided by solid state physics, the dynamic isolators can be made by the periodic material to exhibit special characteristics that are useful in resisting the loads imposed on structures from dynamic excitations. Possessing distinct frequency band gaps, this periodic material will block, or reflect, the incoming dynamic motion with the frequencies falling between these gaps. The frequency band gaps can be controlled by their design and manufacture, exactly what is needed for dynamic isolators. One can properly design the frequency band gaps to match the fundamental frequency of the infrastructure so that its dynamic response will not be amplified; alternatively, one can design the frequency band gaps to match the strong energy frequency components of the design dynamic load.

Biography

Yi-Lung Mo, F.ASCE and F.ACI, is Professor at the Civil and Environmental Engineering Department, University of Houston (UH). He is also Tsinghua Chair Professor, Institute of Future City and Infrastructure, Tsinghua University, Beijing, China. Dr. Mo's technical interests are multi-resolution distributed analytical simulations, network analysis, large-scale concrete structure testing and field investigations of the response of complex networks and structures, on which he has more than 400 research publications, including 197 referred journal papers, many conference, keynote and prestige lectures, research reports, books and book chapters, magazine articles and earthquake field mission reports. Dr. Mo has successfully supervised six post-doc, 23 PhD and over 40 Masters Theses as well as 25 visiting scholar studies. Many of his students hold significant positions in industry, academia and government around the world. In the past several years, Dr. Mo has focused on periodic material research, especially application of periodic material to dynamic isolation of energy infrastructures.

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