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Structural optimization for buildings under stochastic excitations

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The overarching goal of structural optimization is to identify the best design solution that can provide the most favorable performance, while satisfying given design constraints. One of the significant requirements of the structural component and system design is to withstand stochastic excitations, such as earthquake and wind loads. Consideration of such unpredictable yet unavoidable lateral and vertical loads can directly influence the building safety and increase the robustness of building performance. Thus, the randomness of the excitement induced by natural disasters must be considered in the structure analysis and design process. This paper presents a stochastic design and topology optimization framework in the time domain based on random vibration and reliability analysis. The framework incorporates the effect of earthquake excitation in the stochastic process into the analysis and design process of a building structure. The performance and reliability of the structure under stochastic excitations are assessed over a given time interval by considering the first-passage probability, i.e., the probability of at least one failure event occurring over the given time duration. In order to incorporate this design consideration, an efficient evaluation of a series of points in time is developed for the first-passage probability and sensitivity analysis. A case study and numerical applications are presented to demonstrate the validity and effectiveness of the proposed stochastic optimization framework.

Biography

Junho Chun received his MS in Civil and Environmental Engineering from University of California, Berkeley in 2007. He then joined the Chicago branch of Skidmore, Owings and Merrill LLP., an architectural and engineering firm and worked as a Structural Engineer for three years. He received his PhD in Civil and Environmental Engineering from University of Illinois, Urbana-Champaign in 2016 and joined the School of Architecture at Syracuse University as an Assistant Professor. His research interests include structural design and topology optimization under natural hazards, random vibrations, systematic treatment of uncertainty, reliability & risk analysis, and resilient infrastructure.

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