ABSTRACT

Gómez, Daniel Ph.D., Purdue University, August 2019. Human-induced vertical vibration on pedestrian structures: numerical and experimental assessment. Major Professor: Shirley J. Dyke.

In recent years civil engineering structures such as floors, footbridges, and staircases, have reported unacceptable vibration when they are dynamically excited by pedestrians. When such structures have a particular combination of high structural flexibility and low inherent damping, there is potential for excessive vibration. Pedestrian-structure interaction (PSI) is especially noticeable when the lowest structural natural frequencies are close to the dominant pedestrian pace frequency or its harmonics. Although most of these structures are designed according to existing standards and guidelines, there are still many uncertainties in the human actions that may lead to unexpected structural behavior, increasing the vibration responses and exceeding serviceability limit states. How a pedestrian excites a structure and how that structure affects a pedestrian's gait is not fully understood. Therefore, a realistic analysis of PSI must be performed to properly incorporate these effects toward more rational structural designs. This study aims to identify, within this class of the walking-induced load problem, the vibration mechanisms, the mathematical models, and methods, to address excessive vibration in pedestrian structures. After conducting an in-depth evaluation of current guidelines and provisions for analysis and design of pedestrian structures, models to enable more realistic design under such uncertainties have been developed. The results establish a body of knowledge regarding human loads and structural responses, yielding the potential for more rational approaches to improve the analysis and design of pedestrian structures.