DYNAMIC RESPONSE PREDICTION OF LIGHTWEIGHT PEDESTRIAN STRUCTURES: EQUIVALENT CROWD-STRUCTURE SYSTEM

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Summary

In the analysis of lightweight footbridges subjected to pedestrian actions, the vertical dynamic response is often overestimated when Human-Structure Interaction (HSI) is omitted. To account for the phenomenon, a Single-Degree of Freedom (DOF) system has been employed to represent a person. When dealing with a stream of people, this approach may lead to an expensive computational problem as several DOFs have to be managed. An alternative to overcome this issue is modelling the crowd as a distributed Mass-Spring-Damper-Actuator (MSDA) system acting on the structure, as displayed in Fig. 1. Hence, an equivalent time-invariant system with two DOFs can be obtained while considering HSI. This paper proposes a procedure to determine the resonant response of pedestrian structures subjected to a flow of walking pedestrians. Through the construction of a Transfer Function in the frequency domain, accounting for the parameters of the crowd and the structure, the dynamic analysis can be addressed by computing a simple algebraic multiplication.

The proposed approach is applied to a lightweight Fibre Reinforced Polymer footbridge, which has been recently designed and built by the authors at the School of Civil Engineering – Universidad Politécnica de Madrid. A weak traffic class (0.2 pedestrians/m^2) is the considered load scenario for the assessment of the structural acceleration response. As a good agreement between experimental and numerical results is shown, the proposal may be employed for the fast prediction of the dynamic response of other lightweight pedestrian structures at design stage.

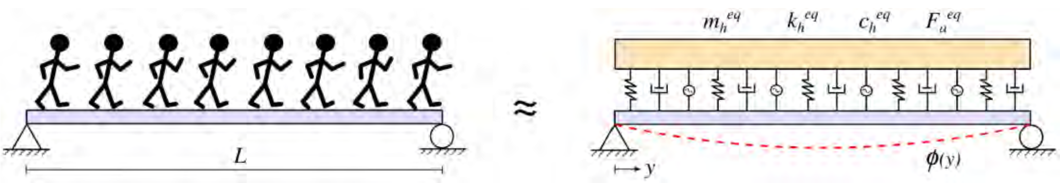

Fig. 1. Representation of a crowd through a distributed MSDA system.

Keywords: lightweight footbridges, vertical dynamic response, crowd, Human-Structure Interaction, Vibration Serviceability Limit State.

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