39th IABSE Symposium – *Engineering the Future*
September 21-23 2017, Vancouver, Canada

Vibration control of footbridges under pedestrian loading using tuned mass damper systems with eddy current damper technology

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Abstract

Footbridges are prone to vibrations induced by pedestrians depending on the bridge`s natural frequencies. Well-known measures to increase the structural damping of a footbridge and hence control the risk of vibrations are Tuned Mass Dampers (TMD). One of the main parameters defining the overall effectiveness of a TMD is its damping mechanism; for this purpose eddy current dampers are an innovative solution, which can improve TMD performance significantly.

This paper describes the design of an eddy current damper as part of a passive tuned mass damper. First, the theoretical potential is analysed analytically. A detailed discussion on the optimization of TMD parameters combined with the characteristics of eddy current dampers shows its advantages. In the second part a TMD construction using an eddy current damper is designed based on a case study of a footbridge.

Keywords: Footbridge; Vibration control; Tuned mass damper; Eddy current damper.

1 Vibrations and footbridges

Modern designs of footbridges often lead to slender constructions with long spans which result in structural systems with a low stiffness and comparatively low masses. A low natural frequency combined with low modal masses is the consequence. This makes footbridges prone to vibrations induced by pedestrians. Constant dynamic excitation causes higher vibration amplitudes in case of low modal masses compared to high modal masses and the risk of unwanted vibrations increases. A low damping ratio can further increase a dynamic problem of footbridges. Therefore a dynamic analysis is common practice during design and construction of footbridges.

Several guidelines exist for the dynamic analysis of footbridges. *HiVoSS* [1] is a commonly used approach. The dynamic behaviour of the bridge structure is defined by simulation during the design process or by vibration measurements after completion of the bridge. In regard to TMDs a common load case for footbridges is pedestrian loading. The way persons tend to walk leads to excitation in horizontal and vertical direction within a certain frequency range. In case of horizontal, lateral vibrations a phenomenon called lock-in has to be taken into account. If a certain level of vibration is exceeded persons will have

https://doi.org/10.2749/vancouver.2017.2248
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