DAMPING ENHANCEMENT FOR STAY CABLES BASED ON INERTER/NEGATIVE-STIFFNESS DAMPERS

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Abstract

Stay cables are prone to rain-wind-induced vibrations (RWIVs) and vortex-induced vibrations (VIVs). The widely used viscous dampers struggle to meet the damping requirements for suppressing RWIVs and VIVs of ultra long stay cables, simultaneously. To enhance the vibration control performance of passive viscous dampers for stay cables, a series of efficient energy-dissipation dampers were invented in our study, including the electromagnetic inertial mass damper, the multi-stage negative stiffness damper, and the inerter negative stiffness damper. The superior control performance of these dampers for cable single-mode and multi-mode vibration control was verified by theoretical analyses and experimental tests. The damping enhancement mechanism of inerter and negative stiffness on stay cables was explored through the energy dissipation ratio of dampers. The results indicate that inerter and negative stiffness can enhance the modal damping ratio of the cable and reduce the installed location and the optimal damping coefficient of the damper. The superior control performance of these damper for cables mainly owes to displacement amplification effect for damping elements by the inerter and negative stiffness, which enhances energy dissipation ability of dampers. The negative stiffness inerter damper can integrate the advantage of the inerter and negative stiffness to enhance the modal damping ratio of the single cable mode. However, the advantage of the inerter degrades with the increase of the control mode order. The multi-stage negative stiffness damper is expected to suppress cable rain-wind-induced vibrations and vortex-induced vibrations, simultaneously by optimizing its location and parameters.

Keywords: *cable vibration control, inerter damper, negative stiffness damper, damping enhancement*