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Passive and Active Spatial Pendulum Tuned Mass Damper with Two Tuning Frequencies

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Abstract : The first bending modes of tall asymmetric structures in the two lateral X and Y-directions have two different natural frequencies. To add tuned damping to these bending modes, one needs to either a) use two pendulum-tuned mass dampers (PTMDs) with one tuning frequency, each PTMD targeting one of the bending modes, or b) use one PTMD with two tuning frequencies (one in each lateral directions). Option (a), being more massive, requiring more space, and being more expensive, is less attractive than option (b). Considering that the tuning frequency of a pendulum depends mainly on the pendulum length, one way of realizing option (b) is by constraining the swinging length of the pendulum in one direction but not in the other; such PTMD is dubbed passive Bi-PTMD. Alternatively, option (b) can be realized by actively setting the tuning frequencies of the PTMD in the two directions. In this work, accurate physical models of passive Bi-PTMD and active PTMD are developed and incorporated into the numerical model of a tall asymmetric structure. The model of PTMDs plus structure is used for a)synthesizing such PTMDs for particular applications and b)evaluating their damping effectiveness in mitigating the dynamic lateral responses of their target asymmetric structures, perturbed by wind load in X and Y-directions. Depending on how elaborate the control scheme is, the active PTMD can either be made to yield the same damping effectiveness as the passive Bi-PTMD of the same size or the passive Bi-TMD twice as massive as the active PTMD.

Keywords : active tuned mass damper, high-rise building, multi-frequency tuning, vibration control
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