# Balcony Vibration Control Using Tuned Mass Dampers

Tuned mass dampers (TMDs) are tuned damping devices commonly used for dampening the vibration of a structure at a particular resonant frequency. TMDs come in various configurations. The commonality between all of them is their make-up which includes an inertia element (mass) suspended by an energy dissipating (damping) device and a restoring (resilient) element.

The irregular shape of three large, 1200 square feet, cantilevered balconies in a high-profile performing arts center resulted in areas at the balcony tip and edge susceptible to potentially annoying levels of vibration. To mitigate this effect, the building designers added tuned mass dampers to the underside of each of the three balconies.

Figure 1 The three balcony system

Following the finite element modeling and actual measurement of the balconies vibration, the results of which were used to size the tuned dampers, nine passive tuned mass dampers were designed, built and installed on the three balconies. They were appended to the vibrating structure (the balconies) at locations where they could most effectively couple with the target mode(s). Figure 2 shows two of the TMDs installed underneath one of the balconies.

Figure 2 Two TMDs appended underneath one of the balconies

The TMDs were tuned to the first two modes of the balconies with the natural frequencies of 6 and 9 Hz. They were placed at locations where they could most effectively couple with their target modes; two TMDs at the edge and one at the tip of each balcony.

The TMDs effectively absorbed oscillatory energy of the structure and dissipated it internally, lowering the vibration due to human activities to an acceptable level.

Figure 3 depicts the spectral and time traces of acceleration measured on the bottom balcony shown in Figure 1.

The blue trace in Figure 3 presents the response of the floor to a heel drop perturbation without the TMDs operational. The red and green traces depict the same measurement when the TMDs are brought online, one at a time.

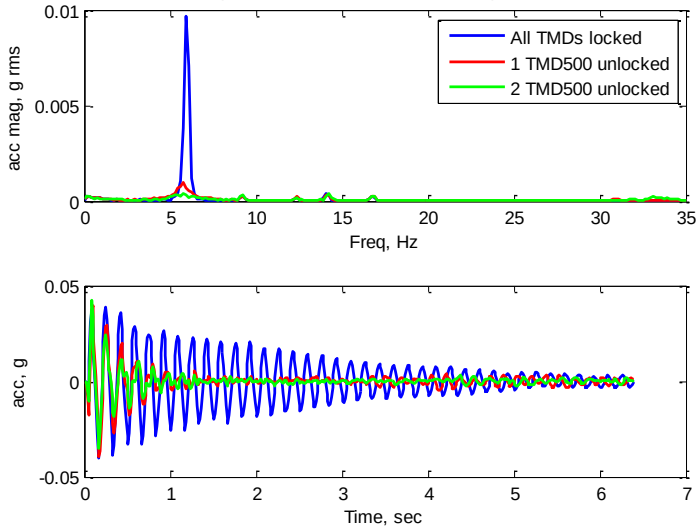


Figure 3 Linear spectra and time traces of acceleration measured without and with the TMDs operational

Clear from Figure 3, tuned mass dampers have effectively dampened the structural mode they are tuned to dissipating its vibration.

***When designed, built, installed, and tuned properly TMDs effectively dissipate the resonant vibration of the structure, reducing its undesirable motion.***