Vibration Control of an Office Floor System 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.

Foot traffic (walking) resulted in vibration of the composite floor system at the 11th floor of an office building. The make-up of the floor system is slab construction consisting of 3.25 inch lightweight concrete fill on 2" deep, 20 gauge composite steel deck with the typical bay sizes of 30 ft x 30 ft and composite steel beam and girder framing. The first resonant frequency and damping ratio of the bay with the most severe vibration were around 6 Hz and 3.5%, respectively.

Figure 1 The office building

With the floor vibration measurement results identifying the first natural frequency on hand, two tuned mass dampers (TMDs) per bay were designed, manufactured and installed at locations where they could most effectively couple with the first mode of the floor system (the vibration mode for which they were designed to dampen). Figure 2 shows one of the tuned mass dampers bolted to the concrete, underneath the floor system. The tuned mass dampers were tuned to 6.5 Hz, i.e., the natural frequency of the mode targeted for damping.

The floor vibration associated with occupant activities, mainly walking, was exacerbated by resonant amplification of the first mode of the underdamped floor system.

The tuned mass dampers effectively absorbed the vibration energy of the floor structure and dissipated it internally, lowering the annoying vibration motion caused by walking to an acceptable level. The blue trace in Figure 3 presents the vibration response of the floor to a heel drop

The floor vibration response is presented by the power spectral density of the measured acceleration.

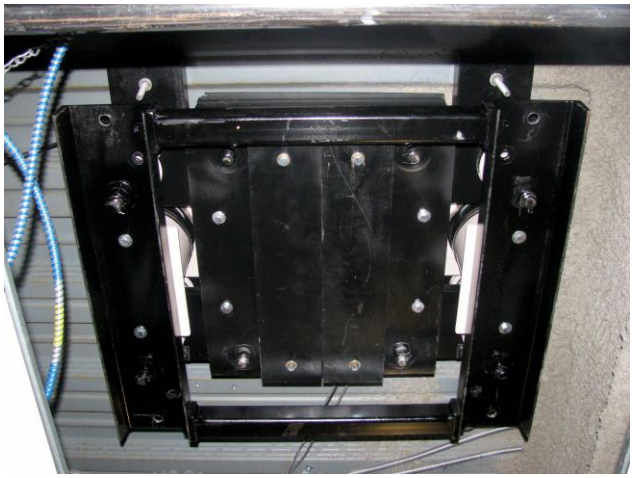

Figure 2 One of the TMDs appended underneath the floor system

perturbation without the TMDs operational (TMDs locked). The red traces in Figure 3 depicts the same measurements when the TMDs are brought online (TMDs unlocked and fine-tuned).

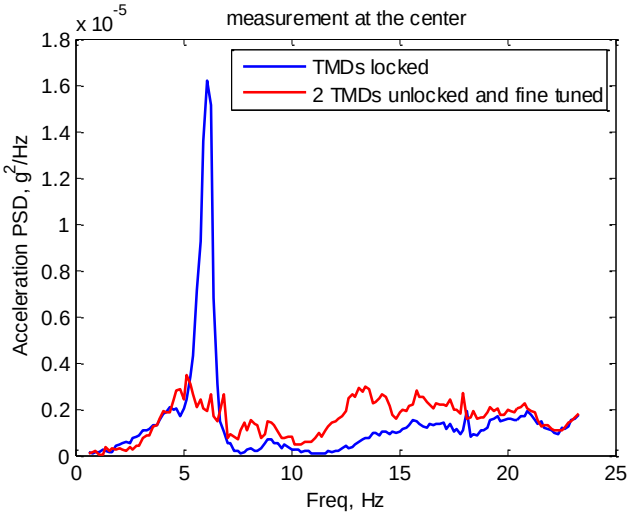

Figure 3 Power spectral density traces of the floor acceleration measured without and with the TMDs operational

As shown in Figure 3, the 8-fold reduction in the vibration power at the target frequency indicates that the tuned mass dampers have dampened the first structural mode they were designed for and tuned to, effectively.