

# Vibration Control of Long Span Balcony Using a Tuned Mass Damper

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.

Excessive vibration of a long span balcony in an upscale residence was addressed by using a tuned mass damper tuned to the natural frequency of the first structural mode of the balcony.

The TMD was sized to have the nominal active mass of 450 Kg. The depth and height of the TMD were chosen so that it can fit within the W 21x182 beam spanning the entire length of the balcony; see Figure 1. The remaining parameters of the TMD namely the tuning frequency and damping ratio were selected based on the measured dynamic attributes of the balcony.



Figure 1 The 60 ft span balcony with the TMD

The blue traces in Figure 2 present the power spectral densities (PSDs) and time traces of the measured acceleration at a location close to the edge of the balcony, in response to a heel drop at the same location, with the TMD locked. The red traces in Figures 2 show the measured data acquired in a similar fashion to those of blue traces except with the TMD unlocked and operational.

Figure 3 shows power spectral densities and time traces of the measured vibration at the same location as that of Figure 2, in response to walking along the balcony edge. The walking pace was selected so that the 2<sup>nd</sup> harmonic of footfall perturbation matched the first natural frequency of the balcony. The comparison of the measured red and blue traces in Figures 3 clearly points to the effectiveness of the tuned mass damper in abating the vibration.

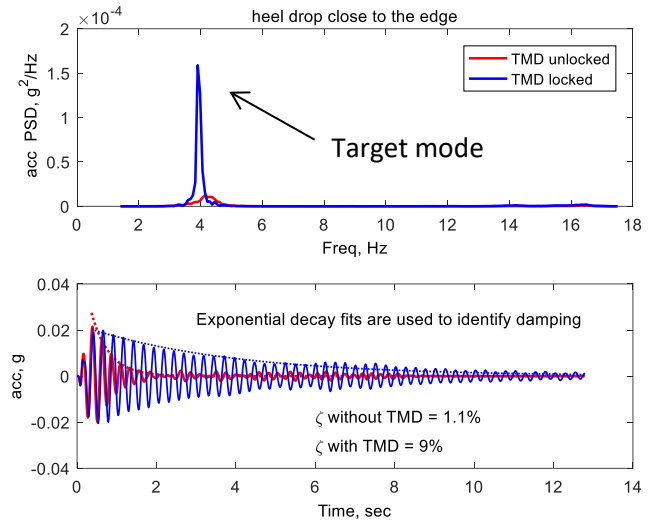


Figure 2 Power spectral densities and time traces of the measured vibration of the balcony+TMD at the center of balcony close to the edge

## Increase in Structural Damping of the Balcony

The extent of damping without and with the TMD operational are also determined by fitting decaying exponentials to their free vibration traces; see the dotted lines on the time traces of Figure 2. As indicated on the bottom plot of Figure 2, the TMD has increased the structural damping of the balcony from 1.1% to 9%; a more than 8 fold increase.

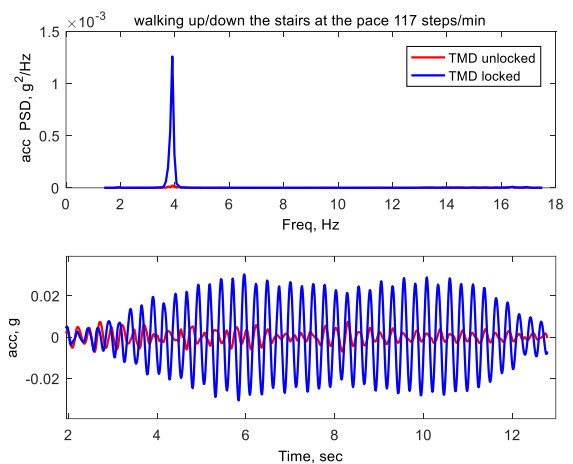


Figure 3 Power spectral densities and time traces of the measured vibration of the balcony in response to walking along the balcony edge