Vibration Abatement of a Natural Gas Piping 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.

Fluid/structure interaction and the operation of one of the natural gas compressors imparted dynamic forces onto one of the compressed natural gas piping systems of a power plant. The frequency of this dynamic perturbation happened to nearly match the first resonant frequency of the piping system, which in turn resulted in excessive resonant vibration of the pipe.

Adding stiffness (to raise the resonant frequencies and separate them from the external force's frequencies) is commonly used as the solution to piping system vibration problem. This solution is costly and installation work, requiring welding, can pose safety hazards.

One 800 lb tuned mass damper with two lateral (X and Y) degrees of freedom and one 400 lb tuned mass damper with one vertical (Z) degree of freedom were designed and built for one of the natural gas piping system at a natural gas-fired combined cycle power plant. The 3 degrees of freedom of the two TMDs were tuned to the first resonant frequency of the pipe at 15 Hz. Figure 1 shows images of the two TMDs (circled in red) installed on the 12" and 10" sections of the pipe.

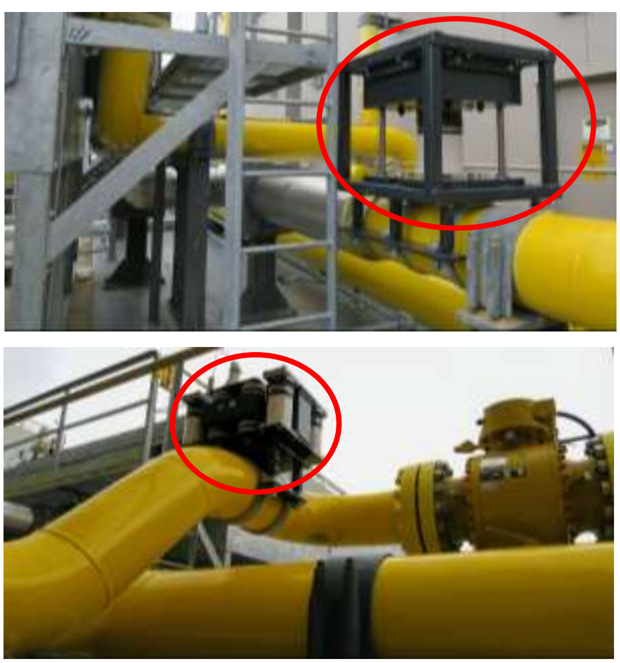

Figure 1 The XY (top) and Z (bottom) TMDs bolted to the pipe

Figure 2 shows the time traces of pipe acceleration, without (blue traces) and with (red traces) the TMDs operational.

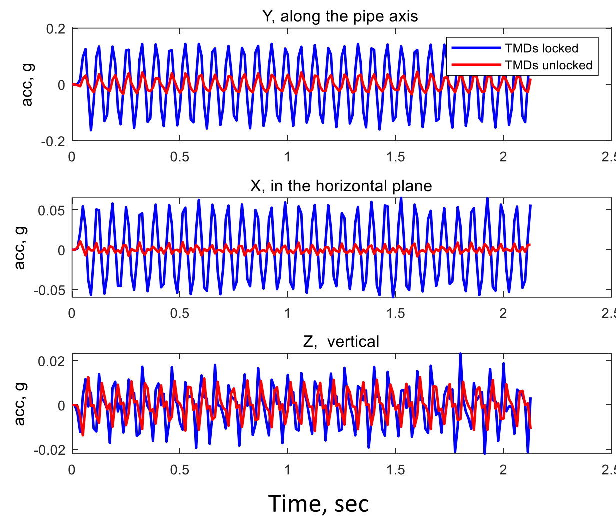

Figure 2 Time traces of acceleration measured close to the X/Y TMD, without (blue) and with (red) the TMDs operational

Figure 3 shows the power spectral densities (PSDs) of pipe acceleration, in lateral directions, without (blue traces) and with (red traces) the TMDs operational.

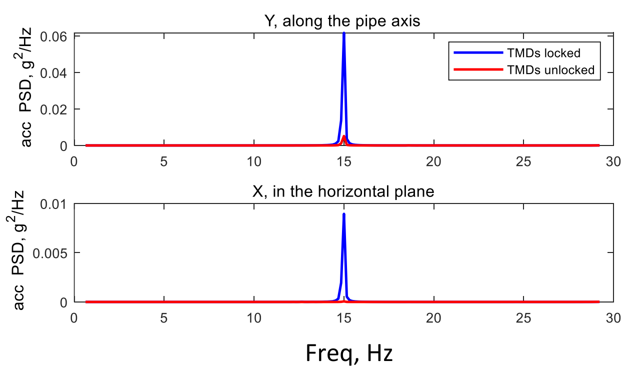

Figure 3 PSDs of acceleration in X and Y directions measured close to the X/Y TMD, without (blue) and with (red) the TMDs operational

The comparison of blue and red traces in Figures 2 and 3 points to the effectiveness of the TMDs in adding tuned damping to the piping system, at their target frequencies resulting in significant reduction (abatement) of the forced vibration of the piping system in all 3 directions.