

Rollercoaster Track Vibration Mitigation Using Tuned Mass Dampers

During a roller coaster ride at a theme park, the loaded train is accelerated along a straight section of track by a linear magnetic motor. Over the course of several seconds, it achieves the speed of 53 m/sec, providing sufficient kinetic energy for the train to reach the top of the tower with the elevation of 128 m. Once passes the summit, the train goes down the other side of the track as being slowed down by magnetic brakes.

As the roller coaster train navigates the 360-degree twists near the summit of the track, it generates significant dynamic forces that act as the primary source of vibration exciting the structure's principal mode, specifically triggering a harmonic response where the support columns undergo bending oscillation.



Figure 1 The track system and the TMDs installed on two of the support columns

Data from accelerometers and strain gauges mounted on the track and one of the support columns confirmed that these vibrations reached excessive levels.

DEICON designed and fabricated two passive lateral tuned mass dampers featuring a moving mass of 1000 kg targeting the principal bending mode of the track structure with the natural frequency of 1 Hz. The TMDs installed near the top of two of support columns of the track, enhanced the effective damping of the structure, lowering its vibration corresponding to their target mode.

Figure 2 shows the time traces and power spectral densities (PSDs) of the structure's velocity measured at the top of one of the support columns, without (blue traces) and with (red traces) the TMDs operational. The large inertia force of the train mass as it travels through the twisting segments of the track, perturbs the entire track structure laterally, exciting the principal mode of the track support structure. A comparison of blue and red traces indicates that the TMDs effectively dissipate the kinetic energy of the structure, successfully mitigating the excessive vibrations.

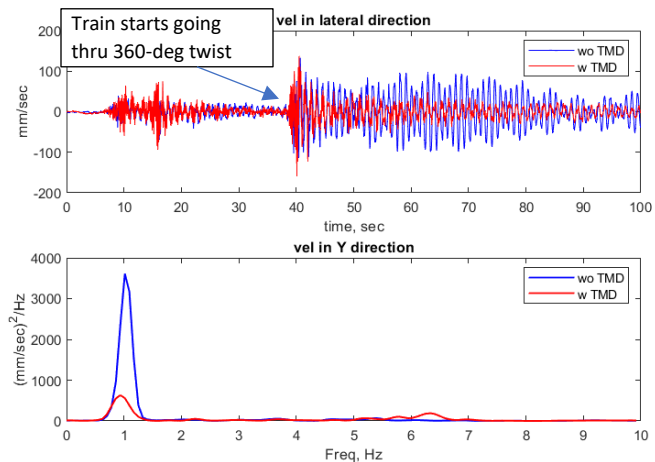


Figure 2 Time traces and PSDs of velocity without (blue) and with (red) the TMDs operational

