

Viscous Damping Devices Rebuilt

The auditorium in one of the premier universities in the Midwest has a massive balcony with the seating capacity in excess of 1100 people. With its large size and its massive first modal mass of 130,000 lb, the balcony's first structural mode of vibration has the low natural frequency of 3.3 Hz when vacant and around 3 Hz when fully loaded with occupants.



To address the low-frequency vibration during events, tuned damping was introduced into the balcony by having four of 4000 lb tuned mass dampers (TMDs), designed and fabricated by others, installed underneath the structure, close to each other along the edge near the tip of the balcony.

The make-up of the TMDs

Each unit is made up of a 4000 lb moving mass along with 4 springs with the stiffness of 580 lb/inch, tuning the TMD to its target frequency.

Viscous damping is provided by two double-acting, double-rod hydraulic cylinders configured as viscous damping devices via plumbing one side of the piston to the other, thru an adjustable flow control needle valve. Energy is dissipated due to the pressure drop across the flow control valve. By adjusting the opening of flow control valve, the required damping coefficient is realized. In addition of the flow control valve, a small bladder accumulator is incorporated in the make-up of the viscous damping devices. The accumulator is pressurized by nitrogen on one side of the bladder and stored fluid on the other side. The

stored fluid is available should there be a loss of few drops of fluid, thru the seals, over time.

After 20+ years of operation, the 8 viscous damping devices of the 4 tuned mass dampers needed to be rebuilt. DEICON was commissioned to do this task by changing all the components of the viscous damping devices with their equivalent brand-new ones, testing the rebuilt units, and adjusting their damping coefficients.

The adjacent figure shows the test device used to evaluate the viscous damping devices. A hydraulic actuator equipped with a LVDT, harmonically strokes the device thru a force sensor. Measuring the force vs. displacement, at various frequencies, leads to the evaluation of the damping coefficient of the device.



Following the accomplishment of the task, the rebuilt damping devices were shipped back to the auditorium and got installed on the TMDs. Subsequent to their installation, the vibration of the balcony, close to the center of the tip of the structure, in response to a heel drop, evaluated pointing to the proper operation of the TMDs equipped with the rebuilt viscous damping devices.

