Vibration Control of Operating Rooms' Floor System in a Medical Center via Stiffening and Tuned Damping

Floor Vibration Limits of Operating Rooms: ISO standard suggests that vibrations in operating rooms not exceed the baseline response values. This corresponds to limiting the RMS vibration velocity to 4,000 micro-inch per second (0.1 mm/sec) at frequencies from 8 to 80 Hz, with somewhat greater velocities acceptable for frequencies below 8 Hz.

Part of an existing building was converted to a medical center with a number of operating rooms.

Vibration Measurement of the bare floor system (without any fit-out) pointed to the first natural frequencies of around 6 Hz for various bays.

Baseline floor vibration limits according to International Standard ISO 2631-2:1989 (E) is:

- The baseline RMS acceleration limit over the frequency range of 4 to 8 Hz, is 500 micro g.
- At 8 Hz, RMS acceleration of 500 micro g correspond to the RMS velocity of 4000 micro in/sec (0.1 mm/sec).

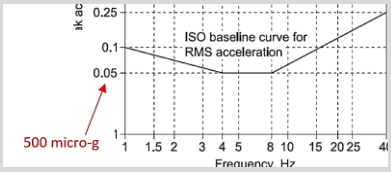




Figure 1 The medical center

Considering that the addition of fit-outs and equipment would lower the natural frequencies of the floor system making it more susceptible to walking induced vibration and the strict floor vibration requirement of operating rooms, it was decided to a) stiffen the existing floor framing and b) add damping to the floor using tuned mass dampers (TMDs).

Eighteen tuned mass dampers were designed, manufactured and installed underneath the operating rooms' as well as the neighboring bays. Figure 2 shows four of these TMDs, bolted to the concrete deck, underneath two adjacent bays of the floor system. The stiffening scheme comprised of welding WT sections to the bottom flanges of existing girders is also highlighted in Figure 2.

Figure 3 presents the measured vibration responses of one of surgery rooms floor to a heel drop perturbation without (blue trace) and with (red trace) the TMDs operational. Large reduction in the vibration points to the TMDs effectiveness in dampening their target modes.

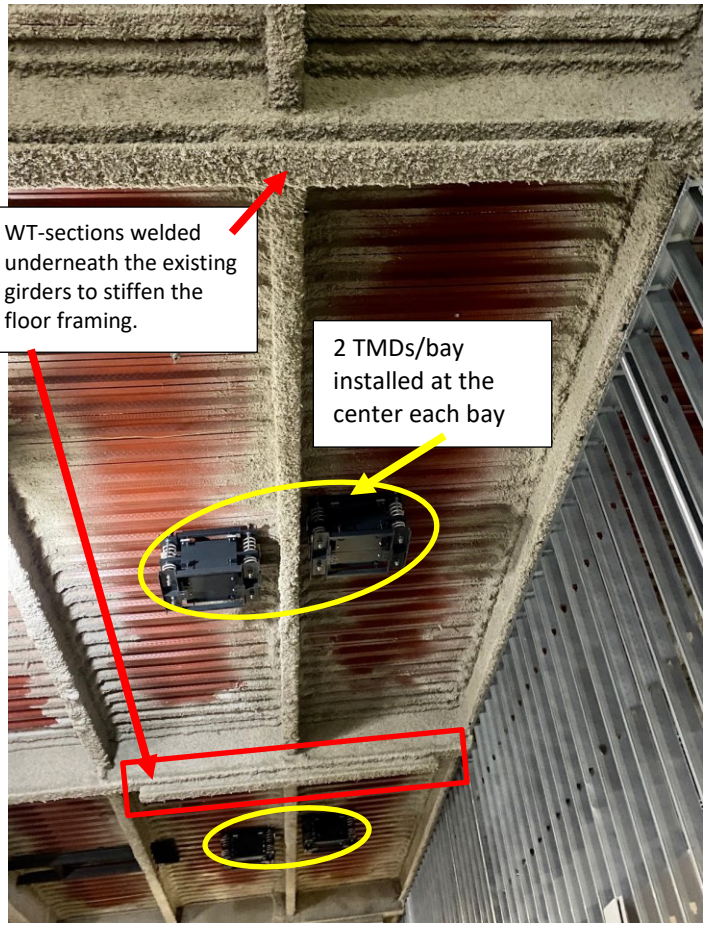


Figure 2 Tuned damping and stiffening scheme

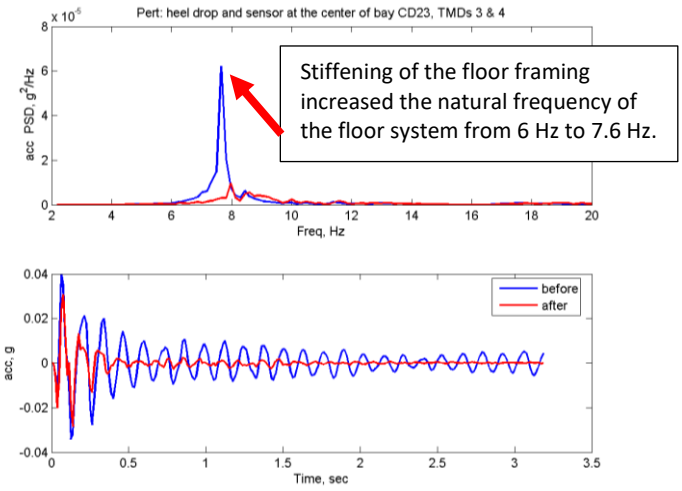


Figure 3 Acceleration measured at the center of one of the surgery rooms floor, without (blue) and with (red) the TMDs operational