TMD Systems for Increase of Damping within High-Rise Buildings

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Abstract

High-rise buildings with long structural periods of 4-5 s and greater suffer due to wind and earthquakes mainly from rather big lateral displacements on top of up to 2m and more. These displacements result in loss of comfort for persons inside and may induce low cycle fatigue due to large, long lasting vibrations after a storm event or earthquake. To overcome these problems damping must be added to the structure.

A technically feasible and also economic approach to increase structural comfort and to reduce the vibration decay times after extreme winds or earthquakes is the application of Tuned Mass Damper systems.

The aim of this paper is to introduce and describe the basic requirements for TMDs and design of two large TMD systems for high-rise structures with their function benefits and damping increase:

- SOCAR Tower in Baku/Azerbaijan is 200 m tall and has a 450 t mass double pendulum type TMD with passive damping, and
- Danube City (DC) Tower in Vienna/Austria is 220 m tall and has a 300 t mass single pendulum type with semi-active damping, which is adopting in real time its damping capability. The system includes a full monitoring of accelerations, frequencies, displacements and viscous damper forces.

Both TMD systems have in addition redundant end stopper devices to avoid uncontrolled seismic displacements of the huge TMD mass block.

The efficiency of the TMD systems was proven by calculation and measurements on site for both projects that accelerations were significantly reduced to provide the necessary comfort and decay times of vibrations due to extreme impacts were limited to a few minutes.

Keywords: High-rise buildings; tuned mass damper; wind; earthquake; semi-active damping.

1 Introduction

High-rise structures have considerably low natural frequencies and are relatively soft in terms of stiffness. This may result in significant lateral deformations on the roof top when exposed to wind or earthquake. While vibrations caused by regular wind occur frequently and may make us feel uncomfortable, earthquake or extreme storm events may not happen often but when happens it may damage the structure. Extreme and moderate load cases lead to different optimum protection needs. And, if a structure has to be protected from both service loads like wind and ultimate

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