The Evolving Metropolis
2019 IABSE Congress
New York City

IABSE 90 YEARS

Full-Scale Performance Evaluation of Structure-Dynamic Vibration Absorber Systems

J. Shayne LOVE

Project Engineer

RWDI Inc.

Guelph, ON, Canada
Shayne.Love@rwdi.com

Since joining RWDI in 2012, Shayne has been involved with dozens of projects involving structural vibration and structural control.

Trevor C. HASKETT

Senior Technical Director

RWDI Inc.

Guelph, ON, Canada
Trevor.Haskett@rwdi.com

Trevor has been working with RWDI since 1999, finding applications for his mechanical engineering training in vibration control to tame the motions of buildings and bridges.

Contact: Shayne.Love@rwdi.com

1 Abstract

Modern tall buildings are often susceptible to excessive wind-induced motion, which can cause occupant discomfort and decrease component longevity. Increasing the effective damping of these buildings using a dynamic vibration absorber (DVA) is often the preferred option to decrease motion, especially for serviceability-level performance. A tuned mass damper (TMD) is one form of DVA that consists of a steel or concrete mass that is supported near the top of the building. A tuned sloshing damper (TSD) is another type of DVA that consists of a tank that is partially filled with water and located near the top of the tower. In both cases, when the building moves during a wind event, the motion of the TMD mass or sloshing TSD water lags behind the motion of the structure. A properly designed DVA thereby produces forces that continually oppose the tower's motion, substantially reducing its response. Although numerous DVAs have been installed worldwide, very little reporting has been published on the full-scale performance of the damping systems. This paper will present the results of measurements conducted on several tall buildings equipped with DVAs. The measured results are compared to theoretical predictions to evaluate performance.

Keywords: high-rise buildings; wind loading; structural motion; tuned mass dampers, tuned sloshing dampers; full-scale monitoring

2 Introduction

Modern tall buildings are often susceptible to excessive wind-induced motion during common wind events. This motion can result in occupant discomfort, and reduce the longevity of nonstructural components such as partitions and facade elements due to large inter-storey drifts. In the past, if wind tunnel testing indicated that a building was expected to exceed the serviceability motion criteria, it was common to increase the building's mass or stiffness to reduce building motions. However, it is often more efficient and cost effective to increase the structural damping.

Although there is considerable scatter in the data set, the inherent damping of many tall buildings is 0.5% - 2% of critical [1]. Increasing the level of damping can dramatically reduce the structural motion. For a building subjected to broadband wind excitation, the peak building accelerations, $\hat{\hat{X}}_0$ and $\hat{\hat{X}}_1$, corresponding to two levels of damping, ζ_0 and ζ_1, respectively, are related by

$$\frac{\hat{\hat{X}}_1}{\hat{\hat{X}}_0} = \sqrt{\frac{\zeta_0}{\zeta_1}} \qquad (1)$$

https://doi.org/10.2749/newyork.2019.0357
Distributed by Structurae