Performance Based Optimal Human Comfort Design of Toggle-Brace-Damper System for Super Tall Buildings

Haojia MA
Research Student
Department of Structural Engineering, Tongji University
Shanghai, China
1432106@tongji.edu.cn

Haojia MA, born 1992, received his bachelor degree from the Dalian University of Technology. His main research area is life cycle structural design and optimization of large scale buildings.

Xin ZHAO
PhD , Senior Engineer
Department of Structural Engineering, Tongji University
Tongji Architectural Design (Group) Co., Ltd.
Shanghai, China
22zx@tjadri.com

Xin ZHAO, born 1975, received his PhD degree from Tongji University. His main research area is life cycle performance based structural design, optimization and health monitoring of large scale buildings

Summary

With the increase of building height, the super tall building structure will be flexible and slim. The structural natural frequency of super tall building is quite close to the predominant frequency of strong wind, and the building acceleration induced by wind load become increasingly prominent. The toggle brace damper system has been proved to be an effective motion amplification device, which can amplify the damper displacement under wind load, and can thus improve the efficiency of the viscous dampers dramatically. In this paper, a new optimal design method for finding the optimal placements, number and parameters of toggle brace dampers is proposed for satisfying human comfort performance requirements under wind loads. The theoretical basis and design process for finding optimum geometry parameter and damping coefficient of the toggle brace damper system are also developed. A real 250 meter super tall residential building project will be employed to illustrate the effectiveness and applicability of the proposed performance based optimal human comfort design method of toggle brace dampers for super tall buildings.

Keywords: Viscous Dampers, Toggle Brace, Human Comfort, Acceleration, Super Tall Buildings.

1. Introduction

With the increase of building height, modern super tall buildings become more and more slender, and the structural natural frequency becomes closer to the predominant frequency of strong wind. Human comfort performance under wind load becomes a very important design constraint, especially for super tall residential buildings which have a demand of high human comfort performance.

Viscous damper have been proved to be one of the most efficient devices to absorb and dissipate large amounts of energy from both earthquake and wind[1]. Because of the small inter-story deformations under wind load, adopting motion amplification devices can amplify the damper displacement under wind load, and improve the efficiency of the viscous dampers dramatically. Constantinou et al. [2] investigated the toggle brace damper system and verified its ability to amplify the axial displacements of dampers and the efficiency of energy dissipation through both cyclic loading tests and shaking table tests with a single degree of freedom steel model.

For super tall buildings, the flexural deformation is as significant as the shear deformation of the building. Hwang et al. [3] proposed new design formulas of viscous dampers corresponding to most commonly used installation schemes such as diagonal brace, K brace, upper toggle brace, and lower toggle brace, which take into account both the relative vertical and horizontal deformation between

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