Outrigger System Optimization under StoryDrift and Vibration PeriodConstraints for SuperTall Buildings

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Summary

Modern tall buildings become taller and slender due to the successive increase of building height. The sizes of the main structural members of the lateralload resisting system are commonlycontrolled by the stiffness design requirements. The designindicesto ensure thestiffness are story drift and natural period in super tall building design practices in China. Outrigger system is an effective measure to increase the overall building stiffness. The outrigger trusses are commonly installed in mechanical floors to minimize the impacts of mega trusses on the building function for super tall buildings.The introduction of outrigger system in super tall buildings will however cause huge steel consumption and high construction difficulty. Effective design optimization method and procedure are necessary to realize optimal outrigger system design under story drift and vibration period constraints.This paper presents a computer-based optimization method which can minimize the material consumption of outriggers subject to story drift and vibration period constraints. The proposed optimization method is based on the virtual work principle, Rayleigh methodand sequential quadratic programming. The effectiveness and applicabilityof theoptimizationalgorithm are illustrated by a 700-meter super-tall building which is a typical mega frame core wall structural system with outriggers. In the process of optimization, the structural members of outriggers areresized in order to utilize the most desirable distributionof structuralmaterial to its best advantage. Results have shown that the proposed optimization methodis a straightforward but powerful tool for the optimal design of outrigger systems.

Keywords:super tall buildings;story drift; vibration period; outrigger system; design optimization.

1. Introduction

Advances in design methodology, construction technology and material science have made it possible to construct increasingly taller and irregularly-shaped buildings. The 124-story Shanghai Tower, the 88-story Jinmao Tower and the 101-story Shanghai World FinancialCenterare the notable examples of such super-tall building structures.Modern super-tall buildings are complex large-scale slim structures. Due to the super height and flexible structure, outriggers were commonly set in mechanical floors to enhance the overall stiffness. However, due to the high construction costof the outriggers, it is desirable to optimizethe quantities,placementsand member sizes of the outriggers. Traditional design method can hardly be employed for the design optimization of structural members due to its time-consuming trial-error procedure by structural engineers.Computed-based automated optimization procedure is more prospective for the engineering design optimization for its high efficiency and precision. To obtain the optimal outrigger systemscheme, the authors developed sensitivity vectors algorithm (SVA) to figure out the optimalquantities and placementsof outriggers subjected to the story drift constraint. Once the

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