Optimal Placement for Buckling-Restrained Braces in Super Tall Building Structures Based on Grid Shear Deformation

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Summary

Buckling-restrained braces (BRBs) dissipate dynamic energy by plastic metallic axial deformation. The energy dissipation capacity depends on the amplitude of axial deformation of the BRBs. The number of BRBs in certain project is commonly limited due to budget constraint. It is always desirable that the BRBs are to be installed in those places which can maximize the energy dissipation during earthquake. For super tall buildings, it is common practices that the BRBs are to be installed in those stories which large story drifts. The storey drift of certain floor is composed of two kinds of deformation, say the rigid body displacement and racking (shear) deformation. This paper proposes to use grid shear deformation (GSD) of each floor for the optimal placement of BRBs due to the fact that only shear deformation will induce energy dissipation. An optimal placement method was developed based on GSD in this study. A super tall building with belt truss frame core-wall structural system is exemplified to show the effectiveness of the proposed GSD based optimal BRBs optimal placement method. The results show that the optimal BRB placements obtained by the proposed GSD method match well with the theoretically best placements which can maximize the energy dissipation. The proposed GSD method can be generally applied for the optimal placement of BRBs in super tall buildings.

Keywords: grid shear deformation; super tall building; buckling-restrained brace; optimization placement.

1. Introduction

The technology of passive energy dissipation systems is widely applied in the design of high-rise buildings to improve the seismic performance. Metallic damper, such as buckling-restrained brace (BRB), is one of the popular passive energy dissipation systems. BRBs use metallic inelastic deformation as means of seismic energy dissipating. For elastic structural state during frequent earthquake, the BRBs can provide enough stiffness as common steel braces. During high earthquake level, such as moderate earthquake, the BRBs commonly behave inelastically to dissipate energy by axial inelastic deformation, and thus protect the main structure from seismic damage.

Different methods and criteria for the design of Buckling-restrained brace have been developed in recent years. For instance, the structures with BRBs are designed using the equivalent lateral force (ELF) procedure as specified by FEMA 450 [4] in the US. Technical specification for building with energy dissipation devices has been published in China this year, with several suggestions and principles about the placement of the devices. Richard. J. balling [5] presented a procedure for the low-rise BRB frames that use both nonlinear time history (NTH) and optimization compared to ELF procedure. Hong Nguyen [6] investigated comparatively the bias and accuracy of modal, improved modal pushover analysis and mass proportional pushover procedures when they are

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