THE STRUCTURAL DESIGN OF TALL AND SPECIAL BUILDINGS
Struct. Design Tall Spec. Build. (2009)
Published online in Wiley Interscience (www.interscience.wiley.com). **DOI**: 10.1002/tal.530

DRIFT OPTIMIZATION OF HIGH-RISE BUILDINGS IN EARTHQUAKE ZONES

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SUMMARY

This paper presents a Drift Design Structural Model (DDSM) for the design optimization of high-rise buildings in seismic zones. The model is formulated as a Generalized Single Degree of Freedom System subjected to equivalent static seismic loadings. The model objectives are: (a) the minimization of the structure weight; (b) the minimization of the structure top drift; and (c) the uniform distribution of the inter-story drifts over the building height in order to minimize earthquake damage through the increase in plastic ductility. Seven high-rise buildings were analysed in order to validate the model, to illustrate its use and to demonstrate its capabilities in structural design optimization in earthquake zones. The results obtained show that the DDSM performed well and consequently can be of practical value to structural designers. Copyright © 2009 John Wiley & Sons, Ltd.

1. INTRODUCTION

In earthquake zones, the top displacement and the inter-story drifts of high-rise buildings must not exceed specified limits with respect to structure and story heights (Carpenter, 2004). Excessive lateral displacements and/or inter-story drifts may cause the failure of both structural and non-structural elements. The traditional trial-and-error design method, which is based on intuition and experience, is time consuming because high-rise buildings are complex and large scale in nature.

Mathematical optimizations provide methodologies to automate the structural design process. Further, one can achieve an optimum design solution out of numerous solutions on the basis of a selected criterion such as minimum weight or minimum cost. A number of articles have been published on the optimization of various kinds of structures with the majority focusing on the minimum weight design due to gravity loads. Only a small fraction of these articles dealt with the optimal drift design due to seismic loads. The published work on the optimal drift design of tall buildings (Park and Park, 1997; Park and Kwon, 2003; Chan, 2004; Chan and Wang, 2005; Lagaros and Papadrakakis, 2007) used structural optimization algorithms, which are based on sensitivity coefficients rather than practical optimizations, and require extensive computational requirements.

This paper presents a design optimization model for high-rise buildings under equivalent static seismic loadings based on the generalized single degree of freedom systems (Chopra, 2001). The proposed model minimizes the building weight and top drift while uniformly distributing inter-story drifts over the building height in order to increase the plastic ductility and to reduce earthquake damage. Hence, the design optimization model can be of practical value to structural designers.

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