Nonlinear Dynamic Earthquake Analysis of Skyscrapers by ABAQUS

Sam Lee

Guangzhou Scientific Computing Consultants Co. Ltd

Abstract: Due to the limitation of computer capacity and the soften of the material constitution, the nonlinear dynamic earthquake analyses of skyscrapers are not practical in engineer's desktop, and even in the research area they are still open problems. Utilizing ABAQUS's unique combination of implicit and explicit technologies and capable of solving large problem efficiently, the author solves the problem elegantly and practically. In the analysis model, all members and shear-walls are modeled by plastic zone model, and large deflection effects are taking into account. Especially, as the shear-walls are divided into element size around 0.7x0.7m, the material and geometry nonlinear buckling behaviors of the shear-walls are modeled almost numerical exact. The main analysis procedures and some key parameters are outlined. The analysis results of some prominent projects in China, such as Shanghai World Financial Center(492m in height), Jinta (330m in height) and Guangzhou West Tower(435m in height), are also presented. The analysis results are of great help for the design engineers to study the skyscrapers earthquake performance and therefore design the skyscrapers structure more safety and economically.

Keywords: Nonlinear, Dynamic, Skyscraper, ABAQUS.

1. Introduction

Seismic design is a very critical issue for skyscrapers built in the seismic area. In the earthquake engineering area, the earthquake loads are usually classified into three levels by their intensities (GB50011, 2001): ① frequently occur level; ② design intensity level; ③ severe level. For the first earthquake load level, the linear analysis is appropriate. However, the skyscrapers shall go into plastic range when subjected to the second and third earthquake intensity levels, therefore a more vigor analysis – nonlinear dynamic analysis should apply.

Nonlinear dynamic earthquake analysis is the most adequate and comprehensive analysis procedure to evaluate the nonlinear seismic response of structures, but currently available computer hardware and design software effectively limit the size and complexity of structures that may be analyzed by this technique. At present, there is no general-purpose nonlinear analysis software that will permit practical evaluation of large structures that include elements with the