Seismic Fragility Analysis of RC Frame-Shear Wall Structures

Huanjun JIANG
Professor
Tongji University
Shanghai, China
jhj73@tongji.edu.cn

Huanjun Jiang, born 1973, received his structural engineering doctoral degree from Tongji University, China. He is currently a professor at College of Civil Engineering, Tongji university. His main area of research is earthquake resistance of building structures.

Xiaojuan LIU
PHD Student
Tongji University
Shanghai, China
2liuxjty@tongji.edu.cn

Xiaojuan Liu, born 1985, received her structural engineering master degree from Huaqiao University, China. She is currently a PHD student at College of Civil Engineering, Tongji university. Her main area of research is performance-based seismic design of buildings.

Lingling Hu
Engineer
Sincere Group Co. Ltd
Chongqing, China
hll18801796572@163.com

Lingling Hu, born 1988, received her structural engineering master degree from Tongji University, China. She is currently an engineer at Sincere Group Co. Ltd in Chongqing, China. Her main area of research is earthquake resistance of RC building structures.

Summary

Seismic fragility was assessed for RC frame-shear wall structures designed according to current Chinese seismic design code for buildings, taking into account the uncertainty of earthquake ground motions. The site soil type and the seismic protection intensity were considered to be the main design variables of the reference structures. Fragility curves for four performance levels, i.e., fully operational, operational, repairable, and collapse prevention, were developed in this study. The plastic rotation at the ends of structural components (or the total chord rotation) and the inter-story drift ratio, which reflect the damage state of the structure from the viewpoint of the structural component level and the story level respectively, were employed as performance indexes. The results indicate that the seismic performance objectives of RC frame-shear wall structures designed according to current Chinese seismic design code can be achieved with good reliability.

Keywords: RC frame-shear wall structure; seismic fragility; nonlinear time history analysis; performance-based seismic design; performance level.

1. Introduction

The reinforced concrete (RC) frame-shear wall structure is one of the most common structure types for high-rise buildings around the world. Its structural behaviour highly depends on the behaviour of the frame and the shear wall, which leads to more complex dynamic behaviour than that of the pure frame structure and the shear wall structure. It is necessary to evaluate the structural seismic reliability of RC frame-shear wall structures by seismic fragility analysis for seismic risk assessment and performance-based seismic design for this type of structure.

Seismic fragility, as a useful tool for showing the probability of structural damage due to earthquakes as a function of ground motion indices, is essential for seismic risk assessment and performance-based earthquake engineering. Since its critical role in regional seismic risk and loss estimation, considerable researches have been conducted in an effort to identify the seismic fragility of structures under the effect of potential seismic ground motions [1, 2]. Generally, seismic fragility can be formulated by fragility curves or damage probability matrices. The seismic fragility functions can be generated by different types of approaches, i.e., empirical method, judgmental method, analytical method, and hybrid method [3-5]. Fragility curves describe the conditional probability that a certain degree of damage will be met or exceeded for a given intensity of ground excitation. The conditional probability is defined as

$$P_{ik} = P\left[D \geq d_i \middle| Y = y_k\right] \quad (1)$$

where P_{ik} is the conditional probability meeting or exceeding the damage state d_i for a given intensity of ground excitation y_k; D is the variable that reflects the damage; and Y is the variable

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