PERFORMANCE-BASED OPTIMUM DESIGN OF REINFORCED CONCRETE MOMENT FRAMES UNDER EARTHQUAKE LOADING

Mohsen TEHRANIZADEH
Professor, Amirkabir University of Technology, Tehran, Iran,
m.teh.2008@gmail.com

Fatemeh Sadat AKHAVAN HEJAZI
PhD. Student, Amirkabir University of Technology, Tehran, Iran,
fatahejazi@gmail.com

Keywords: Performance-Based Design, Design Optimization, Pushover Analysis, Concrete Moment Frame, Least Structural Weight, Uniform Ductility Demands

ABSTRACT

This paper presents an effective computer-based pushover analysis technique for the performance-based design of concrete frames to predict post-elastic seismic demands under equivalent static earthquake loading. Using an energy approach, the performance-based optimization of concrete moment resisting frames is evaluated for the so-called operational, immediate occupancy, life safety and collapse prevention performance levels. Three objective criteria are identified for the performance-based seismic design, which include the least structural weight, uniform ductility demands and also uniform earthquake energy for all the stories. The results obtained for three- and five-story concrete moment frames and compared with the dynamic behavior of these buildings.

INTRODUCTION

The concept of the performance-based structural design based on seismic loading conditions was introduced recently in the literature as (FEMA-273, 1997). To assess the structural performance, the guidelines recommend the use of various methods of analysis including linear static, nonlinear static, linear dynamic and nonlinear dynamic. It is common to use the pushover analysis method for its simplicity and its ability in estimating, with acceptable accuracy, the component, and system deformation demands, without the intensive computational and modeling efforts involved in a dynamic analysis. Therefore, in the performance-based structural design, a nonlinear static procedure is implemented in the analysis to estimate the seismic structural deformations.

In the performance-based design, the main objective is to consider the structural performance in resisting the earthquake loading in a quantifiable manner at various levels, and to achieve more predictable and reliable levels of safety and operability during natural hazards.

A design performance level expresses the desired behavior of the structure under the design earthquake loads. In the performance-based seismic design codes, different performance levels have been defined. The performance levels are categorized according to (FEMA-356, 2000) as: operational (OP), immediate occupancy (IO), life safety (LS) and collapse prevention (CP).

Perhaps Galileo was the first scientist who proposed the structural optimization idea in 1638 through the uniform strength criterion for a bent beam. This work was followed by other researchers such as (Maxwell, 1980).

Performance-based optimum design of reinforced concrete buildings is a relatively new field of research. The performance criteria which are imposed as constraints, affect the initial construction cost that