

Comparison of Seismic Safety in Recent Editions of ACI Regulations Based on FEMA P695 Evaluation Method

Abstract

Occurrence of earthquakes of the late 20th century, e.g., the Northridge earthquake in 1994, has persuaded structural engineers to design structures based on performance. This method considers extent of damage and provides for structure performance and seismic safety level. Structures have several performance levels with the last one being the collapse level. By evaluating the collapse level of performance, seismic safety of a structure can be estimated. To assign a scalar quantity to the seismic safety of a structure, the concept of Collapse Margin Ratio (CMR) was introduced by FEMA P695 to illustrate the seismic safety level.

In this study, safety level of concrete structures designed based on the last three revisions of ACI design code is evaluated and compared based on the analytical method of FEMA P695. For this purpose, five special moment resisting concrete buildings having 3, 5, 10, 15 and 20 stories and three bays spanning 6 meters both ways are selected and designed based on ACI 318-99, 05, and 11 and analyzed by 10 proper earthquake records. The method of analysis is the Incremental Dynamic Analysis (IDA). Linear analysis for design and nonlinear IDA analysis for evaluation are performed by ETABS and SeismoStruct, respectively.

The results demonstrate that the safety level of structures designed based on the newer editions of the design code has been considerably improved, especially from ACI 318-99 to ACI 318-05.

Keywords: performance, collapse level, collapse margin ratio, FEMA P695, concrete special moment frame, Incremental Dynamic Analysis.