17th Symposium on Earthquake Engineering
November 14-17, 2022
IIT Roorkee, India
Paper No. 108

Risk-Targeted Seismic Design of Critical Buildings Using Force-Based Method

Prakash Badal[1], Ravi Sinha[2]

[1]University of California, Davis 95616, USA
[2]Indian Institute of Technology Bombay, Mumbai 400076, India

Abstract

Critical buildings such as hospitals, communication facilities, and

emergency operations centers play vital roles during the response to extreme seismic events. Recent research shows that the inability to ensure continued functionality of such buildings in the aftermath of an earthquake severely impacts the post-disaster response and recovery. Importance factors have been used in the prescriptive force-based design standards to increase the seismic design forces and thereby provide higher safety for such buildings. These importance factors are based on judgment and the associated enhancement of the performance of buildings is not quantified. The present paper describes a generalized risk-targeted importance factor formulation meeting pre-specified seismic risk target levels that is suitable for use with prescriptive force-based design standards. The framework extends the performance-based seismic design methodology to calibrate the risk-targeted importance factors. The framework also accounts for the uncertainty in seismic demand, structural capacity, and inter-building variation within a specific typology. Sensitivity studies for parameter selection are also presented. The methodology is applied to special RC moment frame archetype buildings located in two metropolises in high and very high seismic regions of India (Delhi in Zone IV and Guwahati in Zone V). The paper shows that regular RC moment frame building typology conforming to Indian Standards has an additional risk margin of 25–30% for important buildings (importance factor 1.2) and 65–85% for critical buildings (importance factor of 1.5). The study underlines the need to consider both the seismic hazard and the structural response for the design of critical buildings requiring enhanced performance.

Keywords: Important buildings, Risk-targeted Seismic design, Performance-based seismic design, Disaster risk reduction, Force-based Design, Importance factor