# Functional Seismic Resilience of Reinforced Concrete Building Conforming to Indian Standards

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## Abstract

Functionality and recovery are important resilience attributes but not considered in existing building design and assessment approaches. The study presents different resilience-based metrics based on probabilistic seismic resilience assessment of an archetypical IS code-conforming reinforced concrete building to gain insight in their repair cost, functionality, and recovery performance. This study uses the performance-based earthquake engineering framework. Assessments are conducted for several intensities ranging from return periods of 50 to 9975 years. The results reveal that the IS code-conforming building meets collapse prevention and life-safety objectives. However, time for reoccupancy after a design-level event is about 13 days, while it takes 6 months for functional recovery which may not be acceptable for critical buildings. The study shows that including functionality and recovery-based objectives is essential for design of such buildings.

**Keywords:** Functionality assessment; Seismic resilience; Building reoccupancy; Functional recovery; Code-conforming building; Recovery curve; Performance-based earthquake engineering.

## 1 Introduction

Modern code-compliant buildings perform better in meeting collapse prevention and life-safety objectives but often fail to be reoccupiable and functional for unacceptably long time [1, 2]. These buildings are designed using life safety-based prescriptive standards, which do not control functional recovery after earthquakes. Maintenance of functionality is a very important attribute of resilience since long downtime can significantly add to indirect losses. Performance-based earthquake engineering (PBEE) framework provides an opportunity to incorporate functionality and recovery parameters and access resilience of buildings. Only a limited number of studies [2–8] have attempted to evaluate functionality and recovery performance of buildings. Molina Hutt [3] evaluated the seismic loss and recovery assessment of a 40-story tall archetype buildings and presented different strategies to achieve higher levels of resilience. Cook [9] evaluated the functional performance of reinforced concrete (RC) archetypes and assessed the impact of different design strategies to limit post-earthquake downtime. Molina Hutt et al. [2] found that tall buildings designed under current standards may require up to 7.5 months of repair to regain functionality after a design-level earthquake. They also evaluated the role of more stringent drift limits and other measures to reduce building downtime. Terzic and Kolozvari [4] evaluated the functional recovery performance of a 42-story RC core wall building and found the need for the development of design requirements that consider post-earthquake functionality of tall buildings. Badal and Tesfamaraim [5] assessed the baseline resilience of Canadian code-conforming RC moment frame buildings, developed housing occupancy trajectory, and found that restoration of



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