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Seismic loss assessment of code-compliant moment-resisting RC buildings located on different soil conditions of Mexico City

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ABSTRACT

This research aims to estimate the expected economic losses associated with the repair cost of a set of code-compliant moment-resisting reinforced concrete buildings located on different soil conditions in Mexico City. The loss assessment methodology is based on the second generation of the Performance-Based Earthquake Engineering (PBEE) framework, which quantifies the seismic performance of buildings in terms of metrics such as economic losses, downtime, and casualties, which are more meaningful to owners and stakeholders for the decision-making process. The methodology uses a probabilistic approach that takes into account uncertainties in seismic intensity, structural response, component damage, and consequence prediction. The seismic response of structures was calculated in terms of inter-story drifts and floor accelerations to assess the damage to their structural and non-structural components. In addition, taking into account the seismic hazard of the site, the expected annual losses (EAL) are calculated to provide insight into the seismic performance evaluation of structures with different characteristics in terms of the financial impact in seismic-prone regions like Mexico City.

1. Introduction

The significant improvements in seismic analysis and design procedures in the last decades have contributed to reducing the collapse probability of modern code-compliant buildings to acceptable levels [1–4]. The main goal of current building codes is to protect life safety and do not explicitly consider the potential economic losses aftermath of an earthquake. The extensive financial losses observed in recent earthquakes such as the 1985 and 2017 Mexico City, 1994 Northridge, and 1995 Kobe earthquakes, have brought to light the necessity of considering, in addition to life safety, other important parameters that contribute to the development of seismic resilient communities. Some of these indicators are the economic cost of repair/replacement components, business interruption, downtime of activities, and environmental impact, among others. Therefore, minimizing earthquake-induced economic losses has become a fundamental interest in the Earthquake Engineering community. In this regard, the second generation of the Performance-Based Earthquake Engineering (PBEE) framework has been developed at the Pacific Earthquake Engineering Research Center (PEER). The methodology uses a comprehensive probabilistic procedure that explicitly takes into account the inherent uncertainties in seismic intensity, structural response, component damage, and consequence prediction, which aims to quantify the seismic performance of buildings in terms of some performance metrics that are more meaningful to owners and stakeholder groups for the decision-making process, such as economic losses, downtime, and casualties. This will allow taking risk-informed decisions to develop design/retrofit solutions to minimize losses after the occurrence of an intense seismic event. In recent years, several studies have focused on different aspects that comprise the application of this framework. For example, efforts have been conducted in proposing simplified approaches to facilitate the practical application of the methodology [5–8]; which have resulted in the development of particular fragility functions for structural components that do not exist in the FEMA P58 database for some types of buildings located in different parts of the world. [9,10]. Also, other investigations have evaluated earthquake-induced economic losses of various building typologies and occupancies located in different regions around the world [11–17]. One of the main characteristics of this methodology is that it expresses the seismic performance of buildings taking into account the possible damage to structural and nonstructural components that may be present depending on the use of the building. It should be noted that the consideration of nonstructural components (e.g., infill walls) is of

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