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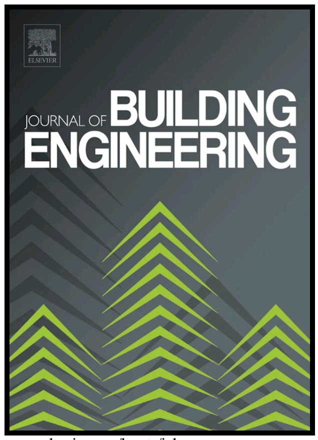

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Seismic Fragility Analysis of Steel Reinforced Concrete Frame Structures based on Different Engineering Demand Parameters

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Abstract:

Nowadays, performance-based seismic design is the focus of earthquake engineering research, in which the seismic performance of a structure is mainly evaluated based on seismic fragility. However, the role of Engineering Demand Parameters (EDPs) on the seismic fragility analysis of Steel Reinforced Concrete (SRC) frame structures remains unclear. This paper presents results on the effects of EDPs on the seismic behavior of a plan-asymmetric SRC building. For this purpose, a nonlinear finite element model of the SRC frame structure was numerically developed using the OpenSees software. This finite element model was then validated using experimental results. The peak interstory drift ratios, as well as the component-based and material-based damage indices, were accordingly employed as EDPs. This study additionally shows seismic fragility curves for an SRC frame structure. The achieved results for the mentioned EDPs were both compared and analyzed. The findings indicated that the EDPs play a role in the seismic fragility analysis for the SRC frame structures. The fragility curves based on a damage index could display the probability of exceeding the ultimate limit states subjected to different seismic intensities, and also showed a similar manner with those based on peak interstory drift ratios. It can be concluded that for an SRC frame structure, the results of seismic fragility analysis using the component-based damage index proved to be more cost-effective and reliable.

Keywords: Steel Reinforced Concrete (SRC) frame structures; seismic damage index; OpenSees; seismic fragility analysis

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1. Introduction

Early use of Steel Reinforced Concrete (SRC) structural systems was well documented in Japan, where post-earthquake field investigations demonstrated the high ductility and energy dissipation capacity of this form of construction. Hence, they have been widely used in the construction project, especially long-span structural systems and high-rise buildings in seismic zones. Meanwhile, many studies have been undertaken on diverse types of SRC components, connections, and frame [1-3]. In Europe, a large research project managed by ARBED of Luxembourg was conducted to investigate the structural performance of these composite members that have proven to provide an alternative solution for fire resistance problems [4].

These studies have confirmed the feasibility of SRC frame structures to resist seismic loading and also left the door open for the further detailed studies on seismic performance of the component, section, connection, and frame. Currently, the seismic performance-based design method has been the mainstream design technique. As a significant party of that design concept, the seismic fragility analysis is defined as a comparison of seismic capacity and demand to estimate whether the seismic capacity was exceeded for a well-defined performance level when the structural system is subjected to specified levels of ground motion intensity. Hence, seismic fragility analysis is a crucial approach for evaluating seismic performance of SRC frame structures and to improve the seismic design, retrofitting, and enhancing reliable decision-making on structural engineering.

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