


Editorial

Special Issue on Advanced Methods for Seismic Performance Evaluation of Building Structures

Sang Whan Han 

Department of Architectural Engineering, Hanyang University, Seoul 04763, Korea; swhan@hanyang.ac.kr

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Abstract: When an earthquake occurs, it causes great damage to a large area. Although seismic engineering continues to develop, it is reported that recently occurred earthquakes inflicted major damage to various structures and loss of human lives. Such earthquake damage occurs in high seismic regions as well as low to moderate seismic regions. This special issue contains topics on newly developed technologies and methods for seismic performance evaluation and seismic design of building structures.

Keywords: numerical models; model parameter; analysis algorithm; seismic performance evaluation; seismic risk; seismic hazard; seismic force resisting system; energy dissipater; seismic design; nonlinear response

1. Introduction

Earthquakes are one of the most dangerous natural events, inflicting damage and the collapse of buildings and infrastructures. On average, 10,000 people lose their lives from earthquakes each year [1]. Although all earthquakes are different in their sizes, they could occur anywhere in the globe. The demand on reducing the risk associated with earthquakes has been growing every year and leads to a greater research focus on seismic design and seismic performance evaluation. Recently, performance-based seismic engineering approach has been being adopted in the earthquake engineering community. In this approach, multiple seismic performance objectives are specified explicitly, which are defined with combinations of seismic hazard levels and structural and non-structural performance levels, unlike conventional prescriptive design approaches. Critical components of performance-based seismic design and evaluation procedures include state-of-art technologies relating seismic hazard analyses, robust numerical simulation frameworks, and sophisticated performance-based seismic design and assessment methodologies. In spite of the fact that major technologies have been developed, many challenging obstacles must be solved to make them implemented in code provisions. The special issue of the journal *Applied Sciences*, “Advanced Methods for Seismic Performance Evaluation of Building Structures,” aims to cover recent advances in the development of major components of seismic performance evaluation and design.

2. Advanced Methods for Seismic Performance Evaluation

This special issue was created to collect the latest and novel research on seismic performance evaluation of building structures. This issue included three important topics on seismic engineering for building structures: (1) seismic design and performance evaluation, (2) structural dynamics, (3) seismic hazard and risk analysis. To protect building structures from earthquakes, it is necessary to conduct the seismic performance evaluation for the structures with reliable methods, and to retrofit the structures appropriately based on the results of the seismic performance evaluation [2]. A total of 25 papers with various topics in seismic engineering were submitted, and 10 of them were published. The acceptance rate was 40%.

The first paper, authored by Z. Xu, Y. Wu, M. Qi, M. Zheng, C. Xiong, and X. Lu, presents a smart and efficient prediction method of obtaining structural types for city-scale seismic damage simulation [3], where machine learning was adopted for efficient calculation. This is a timely research article, because city-scale seismic safety draws more public attention. Simulation of city-scale seismic damage is important because it can provide information about potential seismic damages in buildings that can be used for decision making on urban planning for disaster prevention [4]. The second paper presents a numerical model for simulating ground motions for the Korean peninsula, authored by S. W. Han and H. W. Jee [5]. This paper is valuable because it provides a numerical model for low-to-medium seismic regions that have not been much studied so far. Ground motion simulation models are essential means in seismic hazard analyses [6–8] for low-to-moderate seismic regions because only a limited number of ground motions were recorded in these regions. The third paper, authored by N. H. Dinh, S.-J., Lee, J.-Y. Kim, and K.-K. Choi [9], presents an experimental seismic investigation of a 1000 kVA cast resin-type hybrid mold transformer through tri-axial shaking table tests. This study demonstrated that the damage of the mold transformer was mainly governed by the severe slippage of the spacers and the loosening of the linked bolts between the bottom beam and the bed beam. It is important to conduct research on nonstructural elements because the loss of nonstructural elements due to earthquakes could result in excessive replacement costs [10]. In the fourth paper authored by R. Chen, C. Qiu, and D. Hao [11], seismic responses were numerically estimated for multistory steel frames with buckling-restrained brace (BRB) and self-centering brace (SCB) hybrid bracing system. This study revealed that frames using the combined bracing system take the advantages of BRBs and SCBs. The fifth paper developed a numerical model that is capable of simulating the behavior of reinforced concrete (RC) members and steel-reinforced concrete (SRC) members, which was authored by I. Montava, R. Irlles, L. Estevan, and I. Vives [12]. The sixth paper authored by S. Li and J. Zhang [13] proposed a retrofitting method with an optimum design of viscous dampers to enhance the seismic behavior of a structure. The optimum design of viscous dampers is one of the main issues in seismic retrofit design [14]. In this respect, the content of this paper has value. The paper written by S.-H. Song and S. S. Lee [15] presents finite element vibration analysis considering frequency-dependent soil-pile interaction. The vibration response of equipment foundation structures is not only affected by the structural stiffness and mass, but also greatly influenced by the degree of a soil–foundation structural interaction. This study investigated the influence of the degree of a soil–foundation structural interaction on the vibration response of equipment foundation structures, which has value in earthquake engineering. Z. Chen, J. Wu, and H. Liu [16] presented a paper investigating the seismic behavior of steel plate-concrete shear walls with holes. The ninth paper, authored by S. W. Han, C. S. Lee, M. A. P. Zambrana, and K. Lee [17], proposed a calibration factor for ASCE (American Society of Civil Engineers) 41-17 modeling parameters for stocky rectangular RC columns. Deformation parameters in ASCE 41-17 do not consider height-to-depth ratios, which can significantly alter the column behavior [18]. For RC members with a height-to-depth ratio lower than two (stocky columns), their cyclic behavior is always dominated by shear [19]. The content of this paper is important because shear failure can be accurately predicted with the proposed modeling parameters. The last paper presents the development of an artificial neural network (ANN)-based lumped plasticity model of RC columns using historical pseudo-static cyclic test data, authored by Z. Liu and S. Li. [20]. This study has value because it explores the possibility of using an ANN-based model for the rapid numerical simulation and seismic performance prediction of concrete members.

3. Future Seismic Performance Evaluation

Recently, sophisticated seismic performance evaluation methodologies have been developed to accurately assess the seismic performance of structures. Comprehensive performance-based seismic evaluation method is one of the emerging high-end methods. Although the special issue has been closed, more in-depth research in this topic should be conducted. Such accumulated knowledge

on assessing seismic performance of existing and new building structures could contribute to the improvement of their seismic safety and protect human lives against earthquakes.

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