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Concurrent Probability of Earthquake and Hurricane

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1 Abstract

Infrastructures are inevitably affected by multiple hazards during their service lives. Extreme loads, although occurring in a low frequency, may lead to catastrophic accidents and significant socioeconomic losses. Currently, research work on multi-hazards can be categorized into three groups: (1) joint hazards analysis, (2) physical vulnerability of a structure, and (3) damage analysis of a structure. However, the risk analysis of a structure is usually conducted to assume that the effect of multiple hazards on the structure is the superposition of effects caused by different kinds of hazards, and the interaction of hazards on structural effects is not considered. This paper proposed a theoretical evaluation method for concurrent probability of earthquake and hurricane, which is the basis for multi-hazard analysis of structures. The theoretical solution was validated to be reasonable by the numerical results from Monte Carlo method.

Keywords: infrastructure; concurrent probability; earthquake; hurricane

2 Introduction

In recent decades, most parts of the world have suffered from one or more natural disasters, such as the 1900 hurricane in Galveston and the 1995 earthquake in Japan.

Multiple hazards could be divided into concurrent hazards and cascading hazards according to the mechanism of action [1]. Concurrent hazards mean that two or more disasters are independent of each other, considering the spatial and temporal coincidence of natural hazards. Cascading hazards refer to the correlation of two or more disasters, and one hazard triggering other hazards. For example, an earthquake may trigger landslides [2].

For most of current research cases on concurrent hazards, only the simple superposition of losses caused by different kinds of hazards on an urban infrastructure was considered. Asprone et al. [3] separately calculated the annual collapse risk probabilities of a building under earthquake and explosion conditions, and superimposed them to get the annual collapse risk probability of the building. It was assumed that the earthquake and explosion were independent to each other, but the collapse risk of the structure when the earthquake and the explosion occurred simultaneously was not considered. Yin and Li [4] analyzed the light-framed timber houses subjected to earthquake and snow load, and considered the simultaneous effects of earthquake and snow loads by assuming the participation coefficients of snow loads. However, the effects of concurrent hazards may mutually inhibit or promote each other [1]. Therefore, simply superimposing disaster losses will underestimate the damage caused by disasters. Li and Ellingwood

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