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Framework of Bridge Design Method under Multi-Hazard and Its Application to Super-Span Multi-Pylon Cable-Stayed Bridges

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Abstract

In common practice of bridge design, each hazard is considered and inspected individually. In recent years, more and more bridge collapse accidents expose defects in current bridge design methodology. Researches about comprehensive demand for all hazard scenarios, including simultaneous and/or cascaded hazards events, are of great significance. Reasonable bridge design method should include all possible hazard scenarios in an integrated manner in order to mitigate the structural risk under multi-hazard in the life-cycle and achieve structural performance that satisfies owner and societal expectations. This paper presents an innovative performance, risk, life-cycle based framework for bridge design method emphasized on multi-hazard consideration. The proposed formulation divides the whole bridge design process into six steps, namely preliminary design, hazard analysis, performance design, risk assessment, hazard mitigation measure design, life-cycle cost analysis. The ultimate objective of the bridge design process according to the proposed design method is a design scheme that has minimum life-cycle cost on condition that it meets specified performance standards and risk criteria. The proposed framework is illustrated through an application example of two super-span multi-pylon cable-stayed bridges, which are alternatives for Qiongzhou Strait Bridge design scheme. The feasibility of the proposed design method is verified among its application, in which one design scheme with satisfactory safety, functionality and relatively lower total cost is recommended.

Keywords: multi-hazard; bridge design method; multi-pylon cable-stayed bridge

1 Introduction

Current bridge design methods often take into account limited hazards separately. Consideration for comprehensive demand about all hazard scenarios, including hazard scenarios of a single hazard and hazard scenarios of hazard combination has rarely been reported. Design method considering individual hazard will lead to an unreasonable bridge design especially when the structure is confronted with multiple hazards. To improve the disaster resistance capacity of bridge during the design process, a more reasonable bridge design method considering all possible hazards in an integrated manner should be proposed urgently.

An essential distinction between “multi-hazard” design and conventional design is the consideration for comprehensive demand of all hazard scenarios. Currently bridge design method of representative hazard and the effect analysis of bridge under some hazard combination scenarios have been studied widely. However, the principles and process of bridge design considering multi-hazard are rarely reported, the integrated bridge

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