



Seismic Fragility Analysis of Bridge by Combining the Uniform Design Method and Response Surface Method

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Summary

In view of the large calculation research situation of the seismic fragility of bridges, the paper takes a continuous girder bridge as case-study, accounts for the uncertainties derived from the structural and earthquake ground motion. Combined with the uniform design (UD) and response surface methodology (RSM), an alternative seismic fragility analysis method is proposed. In order to verify the validity and applicability of the proposed method, what through comparisons in sampling frequency and computing time, response surface model accuracy and seismic fragility curves between the proposed method, Monte Carlo (MC), orthogonal design (OD) and central composite design (CCD) of response surface methodology. The case-study shows that the proposed method can be well applied to seismic fragility analysis efficiently and effectively. The results of fragility analysis of the proposed method are very close to Monte Carlo of response surface methodology. In terms of the sampling frequency and computing time, compared with Monte Carlo (MC), orthogonal design (OD) and central composite design (CCD) of response surface methodology, the proposed method is reduced by 99.70%, 58.49% and 8.70% respectively. And as for the structures response surface fit coefficients, compared with orthogonal design (OD) and central composite design (CCD) of response surface methodology, the proposed method are increased by 8% to 12% and 3% to 5% separately. Therefore, the proposed method has good application value in seismic fragility analysis.

Keywords: continuous girder bridge, seismic fragility, uniform design, response surface method.

1. Introduction

As an important tool for performance-based seismic design and seismic risk evaluation, seismic fragility analysis can comprehensively quantify the probabilistic seismic performance of the bridge structure, which is important to maintain the smooth flow of lifeline engineering and reduce the loss of life and property.

Seismic fragility analysis reflects the conditional probability of bridge structure under different intensity ground motions, when their seismic demand capacity exceeds the specified damage states. A large number of researches have been carried out by the domestic and foreign scholars on the seismic fragility analysis. Currently, the seismic fragility analysis methods are based on either the empirical data or the theoretical data[1]. The former has some limitations, while the latter considers the uncertainties derived from the ground motion and structures, and the fragility curves of bridge system or components can be obtained by a large number of numerical simulation method. WU et al.[2] developed the fragility analysis based on incremental dynamic analysis (IDA) method for large span and high pier continuous rigid frame bridge. Hwang et al.[3] established the bridge seismic fragility curves based on Monte Carlo simulation method. LI et al.[4] using Latin Hypercube Sampling (LHS) method, which is based on the traditional reliability analysis methodology, to