Probabilistic response evaluation for RC flexural members subjected to blast loadings

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Abstract

The probabilistic responses of the maximum displacement and displacement ductility factor for a reinforced concrete (RC) flexural member against potential blast loadings are evaluated through a nonlinear dynamic analysis of its equivalent single-degree-of-freedom (SDOF) system. Monte-Carlo simulation is used in the analysis. Some differences are observed between the actual responses of the RC member and those of the equivalent SDOF system due to the complex behaviours of reinforced concrete structural members under blast conditions. Two non-dimensional indices are defined to quantify the differences and their expressions are generated through a large amount of numerical and statistical analyses. The approach of utilizing the indices into a probabilistic response assessment of RC flexural members accounting for different kinds of uncertainties is illustrated via four numerical examples which are verified through nonlinear dynamic finite element analysis. It is concluded that the probabilistic response of RC flexural members obtained from the developed approach have a similar distribution with those from probabilistic nonlinear finite element analysis.

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Keywords: Equivalent SDOF system; Non-dimensional indices; Maximum displacement; Displacement ductility factor; Monte-Carlo simulation

1. Introduction and background

Information on the probabilistic responses of the maximum displacement and displacement ductility factor is of critical importance for the reliable design or analysis of reinforced concrete (RC) flexural members that might be affected by blast loadings [1–3]. The probabilistic analysis based on a combination of nonlinear dynamic finite element analysis of structural members under blast conditions and Monte-Carlo simulation is computationally considerably more expensive due to the significant geometric and material nonlinearity of RC members [4–6]. Therefore, a simple and efficient way for probabilistic evaluation of the blast responses for RC members is necessary.