Reliability analysis of high-rise buildings under wind loads

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Abstract

Traditionally, structural analysis is based on deterministic approaches, i.e., each parameter of analytical model is considered to be a certain value. In fact, uncertainties exist in design, construction, operation and maintenance of real structures. Consequently, traditional analysis is not able to effectively capture structural properties. On the basis of probabilistic approaches, reliability analysis is used to simulate probability distribution of each parameter, implying that uncertainties can be reasonably modeled by such method. This fact indicates that reliability analysis is a more appropriate tool than traditional analysis. In Taiwan, both structural safety and occupant comfort of high-rise buildings have become important due to frequent typhoons, implying that wind hazard is a significant factor for design purposes. Uncertainties of both wind loads and high-rise buildings have to be considered for structural design. From the above description, reliability analysis is useful for exploring the problem of high-rise buildings under wind loads.

The objective of this paper is to conduct the reliability analysis of high-rise building under wind load. Numerical examples are provided to capture the dynamic effects of elastic center eccentricity in the structure. The framework of this paper consists of two stages. The first stage includes two parts: the computation of wind-induced acceleration responses for a variety of attack angles, i.e., demand, and the determination of allowable acceleration response based on the comfort criterion of occupants in the building, i.e., capacity. According to the results obtained in the first stage, the reliability analysis is conducted in the second stage, which can predict the probability of failure for a variety of probability distributions of elastic center eccentricity. The results indicate that, compared to both lognormal and type I extreme value distributions, the normal distribution can more conservatively simulate the uncertainties of elastic center eccentricity from the design viewpoint.