Non-probabilistic convex model process——a new kind of time-variant uncertainty analysis theory and application in structural dynamic reliability problems

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This paper presents a new method called "non-probabilistic convex model process" for time-variant uncertainty analysis, which deals with dynamic uncertainty analysis of structures lacking of experimental information effectively. According to the theory of "non-probabilistic convex model process", the "uncertain process" can be seen as a family of interval variables which are derived from discrete time points of the process, then auto-covariance function and correlation coefficient function are built to describe the relativity between these interval variables. Some important characteristic parameters of unidimensional and bidimensional non-probabilistic convex model process are defined; the definition of stationary convex process and its ergodicity are also provided. Subsequently, by taking the first-passage failure mechanism into consideration, an analysis model of structural dynamic reliability and the corresponding algorithm based on Monte Carlo simulation are constructed. Finally, the method was applied to several numerical examples.

Keywords: time-variant uncertainty; non-probabilistic convex model process; interval model; ellipsoidal interval; structural dynamic reliability; first-passage failure model; Monte Carlo simulation