A Modified Chaos Control Approach of the Performance Measure Functions for Reliability-based Design Optimization

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Abstract

According to the type of probabilistic constraints, Reliability-Based Design Optimization (RBDO) can be solved by two categories, the Reliability Index Approach (RIA) and the Performance Measure Approach (PMA). It is found that PMA is more robust and efficient than RIA during the optimization process. The advanced mean value (AMV) method, as a numerical tool, is widely used for PMA because of its simplicity and efficiency in searching the Most Probable Point (MPP). Moreover, some other methods, such as Conjugate Mean Value (CMV) method, Hybrid Mean Value (HMV) method and the AMV method with chaos control, were also proposed to improve the AMV method in recent years. However, the AMV, CMV and HMV methods can not converge to the MPP for some highly nonlinear performance functions. Although the AMV method with chaos control can converge relatively robustly, the computational efficiency is still a problem.

In this paper, a modified chaos control on the AMV iterative procedure is proposed by scaling the iterative step to the boundary of reliability index constraints during the chaotic dynamics analysis. Considering the simplicity and efficiency of the AMV method in searching the MPP for simple performance functions, the AMV method or the modified chaos control method is selected adaptively for different type of the performance measure functions during the RBDO procedure. Different RBDO approaches, such as two-level RBDO approaches and decoupled RBDO approaches, are compared and tested for some RBDO benchmark problems. The results demonstrate the simplicity, efficiency and robustness of the proposed method, compared with other iterative method.