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A hybrid descent mean value for accurate and efficient performance measure approach of reliability-based design optimization

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Abstract

The robustness and efficiency of performance measure approach (PMA) depend on the reliability loop in reliability-based design optimization (RBDO). For the reliability loop in the PMA using the minimum performance target point (MPTP) search, existing approaches can obtain stable results but may converge to inaccurate results, and higher computational efforts are required to achieve the optimum results for highly nonlinear problems. In this paper, a hybrid descent mean value (HDMV) approach is proposed based on a novel merit function, which is applied to combine the MPTP search formulas of the descent mean value (DMV) and advanced mean value (AMV). The merit function is used to adaptively control the numerical instability of the inverse reliability analysis for RBDO-based PMA. The accuracy, robustness and efficiency of the proposed DMV and HDMV methods are compared with existing methods through four nonlinear performance functions, two structural RBDO problems and a complex aircraft panel problem. The results illustrate that the DMV and HDMV methods are more robust, efficient and accurate than existing reliability methods. For the aircraft panel problem, a simultaneous buckling pattern is finally achieved by the proposed methods with better performance in terms of both convergence rate and computational efficiency.

Keywords: reliability-based design optimization; merit function; descent mean value; hybrid descent mean value; performance measure approach

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