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An efficient adaptive-loop method for non-probabilistic reliability-based design optimization

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Abstract

For non-probabilistic reliability-based design optimization (NRBDO), existing methods cannot satisfy both efficiency and robustness requirements, especially for complex engineering problems. In this study, an efficient adaptive-loop (EAL) method for NRBDO is proposed based on an improved single loop method and enhanced chaos control method, aiming to enhance the optimization efficiency without sacrifice of numerical stability. The constraint function is reconstructed to improve the efficiency of reliability analysis, moreover, a criteria condition is defined to guarantee the rationality of rough optimum and eliminate redundant constraints. The proposed EAL method can adaptively switch to a proper method, thus both high efficiency and robustness can be guaranteed. Nonlinear numerical examples and complex engineering problems are utilized to demonstrate the effectiveness of the proposed method by comparison with other existing methods.

Keywords: non-probabilistic reliability-based design optimization; efficient adaptive-loop method; improved single loop method; chaos control; complex engineering problem.

1. Introduction

With progress in science and technology, demands for structures are ever increasing to pursue better performance. However, there inherently exist a vast quantity of uncertainties arising from the practical engineering, as well as the involved environmental and operational conditions [1]. Those uncertainties could lead to unreliable solution for deterministic optimum design. Therefore, reliability-based design optimization has become ever more crucial [2, 3].

As a precondition for reliability analysis, it is urgent to develop an appropriate mathematical model for

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