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结构非概率可靠性灵敏度分析方法

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Sensitivity Analysis of Non-probabilistic Reliability of Uncertain Structures

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摘要

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摘要 结构非概率可靠性的灵敏度分析对工程中非概率问题的分析预测和优化具有重要的指导作用。基于结构非概率可靠性指标理论,提出了结构非概率可靠性的灵敏度分析方法。针对极限状态函数为线性的情况,推导出了非概率可靠性灵敏度的解析解。在此基础上,结合函数线性化理论,提出了求解极限状态函数为非线性情况的非概率可靠性灵敏度的近似解析方法。基于求解非概率可靠性指标的优化方法,并结合差分理论,提出了求解非概率可靠性灵敏度的优化方法。给出了算例分析,结果表明了所提方法的可行性。

关键词: 非概率可靠性 凸集模型 区间变量 灵敏度分析 差分理论

Abstract: The non-probabilistic reliability sensitivity analysis of structures plays an important role in guiding the analysis, forecasting and optimization for the non-probabilistic problems in engineering. Based on the non-probabilistic reliability of uncertain structures theory, the non-probabilistic reliability sensitivity is discussed in this study. For linear limit-state functions, an analytical solution of non-probabilistic reliability sensitivity is derived for uncertain structures. Based on this analytical solution, linearization for non-linear limit state function is used to establish an approximately analytical method to calculate the non-probabilistic reliability sensitivity in general cases. Additionally, on the basis of the optimization methods for calculation of the non-probabilistic reliability and the difference theories, an optimization method is presented to calculate the non-probabilistic reliability sensitivity. The results from several cases show that the proposed method is feasible.

Keywords: non-probabilistic reliability convex set model interval variable sensitivity analysis difference theories

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