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论文

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基于加权线性响应面法的神经网络可靠性分析方法

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An Artificial Neural Network Method for Reliability Analysis Based on Weighted Linear Response Surface

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摘要

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摘要 在加权线性响应面法的基础上,提出隐式极限状态方程可靠性分析的神经网络方法。加权线性响应面法不仅形式简单、易于实现,而且可以很好的近似极限状态方程的设计点,但它却不能适应非线性极限状态方程的失效概率计算。神经网络对非线性极限状态方程有很强的近似能力,但神经网络的迭代不如加权线性响应面法那么简单易行,因此提出加权线性响应面与神经网络相结合的可靠性分析方法,这种方法既保证对设计点的精确近似,也保证对设计点附近的非线性极限状态方程的很好近似。与加权线性响应面法相比,本方法计算失效概率的计算工作量有所增加,但对非线性极限状态的计算精度却大大提高。算例充分显示所提算法的合理性和可行性。

关键词: 响应面法 可靠性 失效概率 隐式极限状态方程 人工神经网络

Abstract: Based on the weighted linear response surface (WLRS) method, an artificial neural network (ANN) method is presented to analyze the reliability of the implicit limit state equation. The formulation of the WLRS is very simple, and it is easy to be implemented. The important advantage of WLRS is the design point of the implicit limit state equation can be approximated very well. The disadvantage of WLRS is its inapplicability to the non-linear implicit state equation. Hence, WLRS in conjunction with the ANN is presented to analyze the reliability of the non-linear limit state equation, where the approximation to design point is guaranteed by WLRS and the approximation to non-linear limit state equation in vicinity of the design point is guaranteed by ANN. By use of the presented method to analyze the reliability, the computational effort is increased little in comparing with the WLRS, but the computational precision is significantly increased for the non-linear limit state equation, which is illustrated by the given examples.

Keywords: response surface method reliability failure probability implicit limit state equation artificial neural network

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