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微分等价递归算法的解析格式

Analytical scheme of differential equivalent recursive algorithm

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英文关键词:Differential Equivalent Recursive Algorithm (DERA) analytical scheme system reliability joint failure probability

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中文摘要:

结构系统可靠性分析需要精确、高效的联合失效概率计算方法。微分等价递归算法的提出为联合失效概率计算提供了一条有效途径。但原始的微分等价递归算法是以差分格式给出的,主要存在的问题:(1)摄动量选取需要一定的技巧;(2)当量破坏面的数学意义不明确。本文进一步发展了董聪提出的"计算联合失效概率的微分等价递归算法",处理了两个问题:(1)推导了当量破坏面法矢量的解析表达,避免了摄动量的选取及二元联合正态分布累积概率的计算;(2)发现微分等价递归算法中当量破坏面法矢量是原破坏面法矢量的线性组合,进而提出了新的失效模式合成顺序法则。最后,通过算例对比验证了该方法的有效性和实用性。

英文摘要:

Structural system reliability analysis requires accurate and efficient evaluation of the joint failure probability. The differential equivalent recursive algorithm (DERA) is one of the efficient algorithms for computing joint failure probability. The deficiencies of the original DERA based on difference method were summarized as: a) the perturbation has impacts on the equivalent failure surface (EFS) normal vector, thus it is difficult to select a suitable perturbation; b) unclear mathematical interpretation of the EFS. This paper derives the analytical expression of the EFS normal vector, without selecting a suitable perturbation and computing the cumulative probability of bi-variate standard normal distribution. It concludes that the EFS normal vector is a linear combination of the original failure surface normal vectors, which actually provides a geometric explanation of EFS normal vector. Based on the geometric explanation of EFS normal vector, a more rational sequence of combination is proposed. The accuracy and efficiency of the proposed method were demonstrated and verified by a numerical experiment.

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