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体系可靠度计算中改进的等价平面法

Improved equivalent plane method in system reliability computation

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中文摘要:

具有多个失效模式的结构体系可靠度计算是一个复杂的多维积分问题, 很难直接得到结果, 往往需要采用近似计算。在失效模式间的相关性较弱时一些近似计算方法可以得到较好的估计值, 但是当各失效模式相关性较强时这些近似方法的误差较大。最初的等价平面法是用来计算并联体系失效概率的, 但是需要进行迭代求解, 而且其误差较大。本文推导了串联体系的等价平面法(EPM法)的解析公式, 在此基础上提出了改进的等价平面法(IEPM法), 该方法既可以计算串联体系也可以计算并联体系的失效概率, 解决了体系可靠度在各失效模式相关性较强时近似计算误差较大的问题。经大量的算例验证, 说明该方法在失效模式相关性较强时具有较高的计算精度。

英文摘要:

The reliability computation is a complicated problem for a structural system with multi-failure modes. It is difficult to get the computational results directly, and an approximate method is usually used. If the correlativity between failure modes is very weak, some approximate methods can be found to calculate the system reliability and the calculation accuracy can be quite good. But, if the correlativity between failure modes is quite high, the calculation errors by these methods are usually very big. The original equivalent plane method (EPM) is only used to calculate the parallel system reliability, by which the iteration method is required and the calculation errors are usually quite big. In this paper, an analysis formula of equivalent plane method for calculating the series system reliability is derived firstly, and then an improved equivalent plane method (IEPM) is put forward. The improved equivalent plane method can be used to calculate both series system and parallel system failure probabilities. By using this new method, the problem of calculation accuracy for the system reliability computation with high correlativity between failure modes is solved very well. A large number of calculation examples and comparison, show that this new method has quite high precision for the system reliability computation with high correlativity between failure modes.

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