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Theoretical analysis of non-probabilistic reliability based on interval model

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Abstract: The aim of this paper is to propose a theoretical approach for performing the non-probabilistic reliability analysis of structure. Due to a great deal of uncertainties and limited measured data in engineering practice, the structural uncertain parameters were described as interval variables. The theoretical analysis model was developed by starting from the 2-D plane and 3-D space. In order to avoid the loss of probable failure points, the 2-D plane and 3-D space were respectively divided into two parts and three parts for further analysis. The study pointed out that the probable failure points only existed among extreme points and root points of the limit state function. Furthermore, the low-dimensional analytical scheme was extended to the high-dimensional case. Using the proposed approach, it is easy to find the most probable failure point and to acquire the reliability index through simple comparison directly. A number of equations used for calculating the extreme points and root points were also evaluated. This result was useful to avoid the loss of probable failure points and meaningful for optimizing searches in the research field. Finally, two kinds of examples were presented and compared with the existing computation. The good agreements show that the proposed theoretical analysis approach in the paper is correct. The efforts were conducted to improve the optimization method, to indicate the search direction and path, and to avoid only searching the local optimal solution which would result in missed probable failure points.

Key words: non-probabilistic; reliability; interval model; theoretical analysis; probable failure point

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