

Reliability-based design by adaptive quantile estimation

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Abstract

The safety factor required to achieve certain reliability turns out to be related to the quantile of the normalized performance index of interest. Quantile functions (quantiles as functions of design parameters) are therefore essential to convert a reliability constraint into the equivalent safety-factor constraint. It is shown in this paper that the estimation of these quantile functions can be achieved by fitting the tail of the distribution of the normalized performance index. In the cases where the tail varies drastically with the design parameters, an algorithm is developed to find a series of probability distributions to adaptively fit the tails. Once these probability distributions are obtained, a series of quantile functions can be found to facilitate the conversion of the reliability constraint. Examples are investigated to verify the proposed approach. The results show that the approach can effectively convert reliability constraints into equivalent safety-factor constraints.