論文題目:　Reliability analysis under imperfect information and information updating

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【論文要旨】

In recent years, structural reliability analysis methods and reliability-based design methods have been continuously improved, and the safety of engineering structures has also been improved. However, most reliability analysis and design methods continue to assume that probability models are complete and do not account for imperfect information and information updating. Unfortunately, due to factors such as structural load, environment and performance degradation, the statistical data of some important parameters are incomplete and need to be continuously updated continuously updated during the structural reliability assessment and design process. As a result, it is important to perform the reliability analysis and design that takes into account imperfect information and information updating. Therefore, the objective of the present thesis is to develop effective reliability analysis methods and reliability-based design methods under the imperfect information and information updating. The thesis is organized as follows:

This paper consists of an introduction, a main theory, and a conclusion, and this paper consists of six chapters. The outline of each chapter is as follows.

In Chapter 1, the research background and motivation of this study is introduced.

In Chapter 2, an effective and efficient reliability analysis method under imperfect knowledge about probability distributions is proposed. In this proposed method, the three-parameter lognormal distribution is adopted to approximate the distribution of the conditional reliability index, which has been proved to have a wide range of applications. Based on the obtained conditional reliability index distribution, the predictive failure probability, the quantile values, even the distribution of the conditional failure probability can be directly determined within the same computational framework.

In Chapter 3, a practical approach for performing the load and resistance factors design within a wide range of target reliability indices based on the third-moment transformation is proposed. This new method provides a simple and accurate process to approximate the separation factors and derives a closed-form formula by third-moment transformation to calculate the load and resistance factors. It can also be used when the distribution of random variables is unknown.

In Chapter 4, an efficient method to obtain the explicit posterior distribution of random variables is proposed. When the uncertainty distribution parameters are updated by using the detection information, Bayesian theory is needed, but the integral complexity is difficult to solve. The method can realize the calculation of Bayesian fast integral considering the update of uncertainty distribution parameters and the accurate simulation of the probability distribution function after the update of the distribution parameters, which can provide accurate and more stable structural reliability calculation results; and the time-variant reliability is evaluated by using the updated random variables

In Chapter 5, a new and efficient method is proposed for updating the overall failure probability of deteriorating structures in a Bayesian framework. In the proposed method, the updating factor can effectively separate the components to be updated from the reliability analysis obtained directly with the prior distribution, there the proposed method needs neither the repeating structural reliability analysis nor the repeating derivation of the posterior distributions, thus the computation efficiency will be much improved compared with the existing methods.

Finally, Chapter 6 summarizes the theoretical methods proposed in each chapter and gives an outlook on future research.