Recent Developments in Applied Mechanics with Uncertainties

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Résumé :

It has been recognized during past decades that deterministic mechanics as such cannot answer all problems that arise in engineering. For example, the safety factor that is being utilized in engineering design cannot possibly be justified within deterministic mechanics. Thus, the uncertainty analysis is introduced in deterministic analysis 'via the back door.' The realistic analysis and design of structures demands the introduction of uncertainty analyses. To accomplish this goal, until very recently the only methodology used was the probabilistic analysis initiated by the great French scientists Blaise Pascal and Pierre Fermat. It is interesting to note that the first attempt to utilize the probability in engineering, appears to have been a dissertation by Max Mayer published in 1926 and devoted to safety factor allocation in civil engineering. In this spirit the lecture reviews first the safety factor idea and then the most common method that is applied in stochastic analysis of nonlinear structures, namely the stochastic linearization technique.

Then the lecture deals with alternatives to probability analysis: interval and ellipsoidal analyses and shows which one should be used in which circumstances. In these analyses no probability or fuzzy measures are needed to be known. These analyses depend on scarce knowledge—that is often the case-for involved uncertain variables. Instead the bounds--as either intervals or ellipsoids--are incorporated into the analysis. The notion of combined optimization and anti-optimization will be discussed. At the last part the lecture reviews the notion of the fuzzy safety factor.

Many researchers prefer to use one of these techniques exclusively and maintain that only one of these methods is useful. In fact it appears that there is, as it were, a Babel Tower erected between different methodologies of uncertainty analyses. As pragmatic creatures engineers appear to be in need to know each of these techniques and use them in different circumstances depending on the character and the amount of available data.

Références :

1. *Probabilistic Theory of Structures*, Dover, NY, 1999.
2. *Safety Factors and Reliability: Friends or Foes*, Kluwer, Dordrecht, 2004.
3. *Optimization and Anti-Optimization of Structures under Uncertainty*, Imperial College Press, London, 2010 (with M. Ohsaki).