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ABSTRACT

In view of limited uncertainty information, a time-dependent reliability estimation procedure that combines the determined crack growth model with interval mathematics is presented as a theoretical basis for structural damage tolerance design. Firstly, by virtue of the theory of non-probabilistic interval process, an interval process model of fatigue crack propagation is investigated, in which we describe uncertain crack length $a(N)$ at any load cycle N as interval variable and define the corresponding auto-covariance function and the correlation coefficient function to further characterize the correlation of $a(N)$ at different cycles. By comparison of the critical crack length $a_{critical}$, the uncertainty properties of the time-varying limit-state function can be given as well. Furthermore, inspired by the first-passage approach in random process theory, a new measure index of non-probabilistic time-dependent reliability is proposed as a feasible way for precisely evaluating the safe life of in-service engineering structures with crack. The corresponding solution algorithm is further discussed. Some application examples demonstrate the usage, efficiency and accuracy of the developed methodology eventually.

***Keywords*:** fatigue crack propagation; interval process; correlation; non-probabilistic time-dependent reliability; the first-passage approach

1 Introduction

The fatigue fracture problem, as one of the most common case of structural failure, has been widely concerned and investigated in the fields of mechanics, aviation, shipping, etc [1, 2]. With the continuous development of structural design technology, the early concepts of static strength design and fatigue strength design are also gradually updated by the philosophy of damage tolerance design. People in both engineering and academic domain mainly focus on the characteristics of structures with initial crack, including fatigue crack propagation,