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Fatigue reliability of a stiffened panel subjected to correlated crack growth

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Abstract

The objective of this work is to analyze the fatigue reliability of a stiffened panel subjected to the growth of correlated cracks. A probabilistic crack growth model is applied, allowing for the existence of multiple cracks both in the stiffener and in the plate, accounting for the correlation between them. The geometry functions of the correlated cracks in the plate and in the stiffener are defined from calculations of stress intensity factors applying the finite element method. Monte Carlo simulations are used to define the statistical descriptions of crack growth. The failure probability assessment is performed based on a First Order Reliability method (FORM), in which the residual strength of the plate and stiffener in the stiffened panel are formulated in terms of the crack tip opening displacement. The formulation is extended to account for inspections, updating the probability of failure with its outcomes. Various parameters related to the quality of manufacture, inspections, time interval between inspection, load level and target reliability acceptance are studied.

Highlights

► Fatigue reliability of stiffened panel with two correlated cracks is assessed. ► A probabilistic crack growth model is applied, allowing for multiple cracks. ► Monte Carlo simulations are used for the descriptions of crack growth. ► Failure probability assessment is performed based on FORM. ► The formulation accounts for inspections, updating the probability of failure.

Keywords

Fatigue reliability; Stiffened panel; Crack growth; Inspection; Reliability updating

Figures and tables from this article:

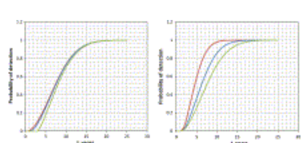

Fig. 1. Probability of detection (POD).

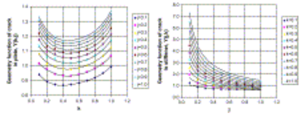

Fig. 2. Geometry function for plate (left) and stiffener (right).

Figure options

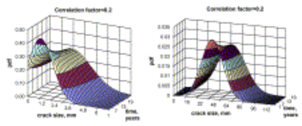

Fig. 3. Truncated normal PDF of crack size as a function of time, plate (left) and stiffener (right) for a correlation of 0.2.

Figure options

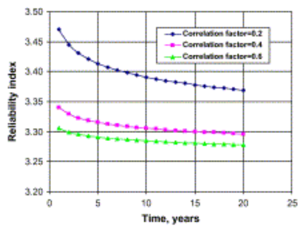

Fig. 4. Reliability index accounting for different correlation factor.

Figure options

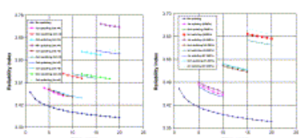

Fig. 5. Updated reliability index accounted for inspection interval (left) and stress ranges (right), without repair.

Figure options

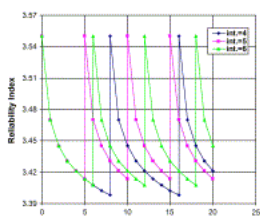

Fig. 6. Reliability considering different inspection interval accounting for repair.

Figure options

Table 1. Statistical descriptors of *A* and *B* for plate and stiffener.

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