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Simulation of Paris-Erdogan Crack Propagation Model:

The Effect of Deterministic Harmonic Varying Stress Range on the Behaviour of Damage and Lifetime of Structure

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Abstract

The classical, basic Paris-Erdogan model $da/dN = C(\triangle K)^M$ is widely applicable and accepted in fracture mechanics, especially in the field of fatigue failure. This model is transformed by the author to simulation model of the form $a_{N+1} - a_N = \lambda a_N^{M/2}(\triangle s_N)^M$. The model relates da/dN, the crack growth per cycle of applied load, to the parameters of stress-range $\triangle s$ and the crack length a. The stress range is one of the important parameters in the model which determines the behaviour of damage and lifetime of any structure. It can be treated as deterministic or random (stochastic) process. In this paper the effect of applying deterministic harmonic varying stress range in the form $s_n = \mu + r\cos(2\pi(n+p)/365)$ is studied where n is the time from 1 to 365 (to indicate the days in a year), μ is the mean and r is the amplitude. Both μ and r are chosen in such a way that the stress-range varied harmonically from $\mu - r = 1$ in the mid-summer to $\mu + r = 9$ in the mid winter. In this equation, p is a phase shift from 0 to 180. It was found that the cumulative damage is at its maximum if it starts during winter and at its minimum if it starts during summer. With the generated parameter values, failure (damage = 1.0) occurs between the sixth and seventh year.

Keywords: Behaviour of damage, crack growth, deterministic harmonic varying stress range, simulation model.

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