[O16.2]

Short crack influence on fatigue limits and stress corrosion cracking resistance

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Most structural components are designed against fatigue crack initiation, using stress/strain analyses that do not recognize any cracks, either short or long. Therefore, their "infinite life" predictions may become unreliable when such cracks are introduced by other means (e.g. by accident during manufacturing or operation) and not quickly detected and properly removed. Large cracks may be easily detected and repaired, but cracks smaller than the NDT detection threshold cannot be identified. Hence, structural components designed for very long fatigue lives should be designed to avoid fatigue crack initiation AND to be tolerant to undetectable short cracks. However, this obvious requirement is still not included in traditional fatigue design routines, which just intend to maintain the stress range at the structural component critical point below its fatigue limit, guaranteeing that $\Delta\sigma < S_L(R)/\phi_F$, where $R = \sigma_{min}/\sigma_{max}$ and ϕ_F is a suitable fatigue safety factor. The calculation of fatigue damage caused by random non-proportional multiaxial loads can be much more involving, but the design philosophy remains the same if it does not consider short crack effects. Nevertheless, most long-life designs work just fine, thus they are somehow tolerant to unavoidable short cracks. But the question "how much tolerant" cannot be answered by safe-life procedures alone. It can only be answered by adding an adequate fatigue crack propagation threshold requirement to the "infinite" life design criterion. However, the tolerance to non-propagating cracks depends on the idiosyncrasy of the short crack behavior, which is particularly sensitive to stress gradients ahead of notch tips [1-3]. Considering this, a criterion to access the tolerance to short 1D and 2D cracks is proposed, using sound mechanical models and no adjustable parameters. Such model is then extended to deal with stress corrosion conditions, in an attempt to contribute to the understanding of how corrosion and fatigue damage interact.

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