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A review on fatigue fracture modes of structural metallic materials in very high cycle regime

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Highlights

- Duplex $S-N$ curves were confirmed for ferrous and non-ferrous metallic materials.
- Various kinds of fracture modes were observed other than interior inclusion-initiated fracture in very high cycle regime.
- Difference between $S-N$ characteristics in rotating bending and axial loading was successfully explained by stress distribution and critical volume participating in the crack initiation.

Abstract:

In $S-N$ diagrams for high strength steels, experimental data in the usual surface fracture mode appears at higher stress levels with fewer loading cycles, whereas the data in the interior fracture mode tends to appear at lower stress levels with the very long fatigue life. Thus, the duplex $S-N$ property was usually confirmed for those high strength steels in such a very high cycle regime. In the case of interior fracture mode, there can be several different types of the crack initiation with/without nonmetallic inclusion at the crack initiation site, and different crack initiation types can be found even for the surface fracture modes in the conventional fatigue life region. In the present work, the authors have attempted to review the overall feature of these fatigue fracture modes appearing at the usual life regime and the very high cycle regime.

1. Introduction

Based on the survey of the researches on very high cycle fatigue for structural metallic materials, we can find several papers published in some periodical journals as the earliest works in this subject. At the early stage of 1980's, A. Atrens et al. had reported the characteristic $S-N$ property for a titanium alloy and a martensitic stainless steel [1] such that the $S-N$ curve tends to decrease again after the horizontal portion

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