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PII: S0142-1123(18)30095-1
DOI: https://doi.org/10.1016/j.ijfatigue.2018.03.011
Reference: JIJF 4612

To appear in: *International Journal of Fatigue*

Received Date: 31 October 2017
Revised Date: 6 March 2018
Accepted Date: 9 March 2018

Please cite this article as: Kanters, M.J.W., Engels, T.A.P., van Erp, T.B., Govaert, L.E., Predicting long-term crack growth dominated static fatigue based on short-term cyclic testing, *International Journal of Fatigue* (2018), doi: https://doi.org/10.1016/j.ijfatigue.2018.03.011

Predicting long-term crack growth dominated static fatigue based on short-term cyclic testing.

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Abstract

In the present work, the time to failure of a glass fibre reinforced glassy polymer is studied in cyclic fatigue at various frequencies and stress ratios with the goal to predict long-term crack-growth dominated static fatigue. It is demonstrated that the crack propagation rate can be regarded to consist of two components: a time-dependent creep component, and a frequency dependent cyclic component. In static loading, the time-dependent component prevails, while for cyclic loads with large load amplitudes the frequency dependent, cyclic component dominates. For intermediate load amplitudes, the total propagation rate is shown to be a combination of both. Consequently, the contribution of the cyclic component diminishes with decreasing frequency or load amplitude, revealing the contribution of the static component. As such, extrapolation of the stress ratio dependence of the fatigue life to $R = 1$ allows estimation of the long-term static performance. A phenomenological model is provided that captures all relevant aspects and provides an accurate description of the stress ratio and frequency dependence of the lifetime in fatigue loading and allows prediction of the long-term failure, based on short-term cyclic fatigue experiments only.

Keywords: fatigue, short glass fiber reinforced, polymer, prediction, crack growth

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