

Dependence of the Fatigue Life of Elastomers on Mean Stress and Stress Amplitude

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Fatigue tests on carbon black filled ethylene propylene rubber (EPDM) reveal physical behaviour that is not seen in conventional linear elastic solids. Uniaxial cyclical tests, using cylindrical dumbbell specimens (Fig. 1), with the same minimum stress of zero ($\sigma_{\min} = 0$), predictably gave decreased fatigue life with increased maximum stress (σ_{\max}) (circles in the (Wöhler-curve, σ -n-plot) Fig. 1). However, tensile uniaxial cyclic tests where σ_{\min} was increased in successive tests whilst the alternating stress (σ_a) remained constant, produced longer fatigue lives for higher values of σ_{\max} (triangles and squares in Fig. 2).

The EPDM compound was chosen for the tests because it does not strain crystallise during deformation and consequently this phenomenon has no influence. These results show that σ_{\max} can not be used as criterion to predict fatigue life of filled elastomers. Preliminary evaluation of recorded data of load vs. displacement or stress vs. strain gave evidence that energies control the fatigue life rather than stress and strain (see Fig. 3).

Investigations on unfilled EPDM elastomers show the typical effect of a Wöhler-curve and also with increasing of minimum stress at the same amplitude the fatigue life decreases as normally expected. The Data plots of the preload variation and the Wöhler-curve show a unique picture as for conventional linear elastic solids (see Fig. 4).

The results of the tests with the unfilled EPDM material indicate that the increase of the fatigue life with increasing minimum stress is an effect of the filler-elastomer and filler-filler interaction.

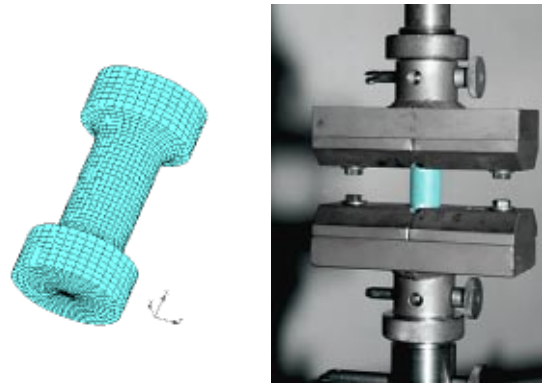


Fig. 1: Geometry of specimen and fixture in the servohydraulic test system

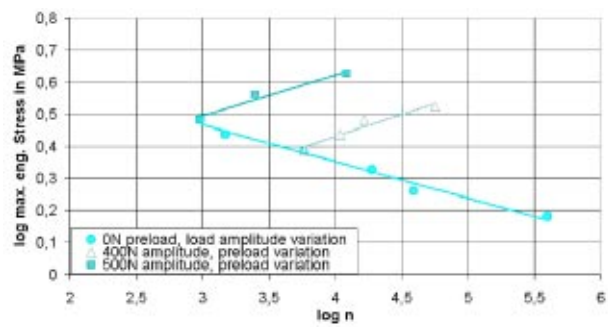


Fig. 2: Maximum Stress Dependency on the Fatigue Life of filled EPDM

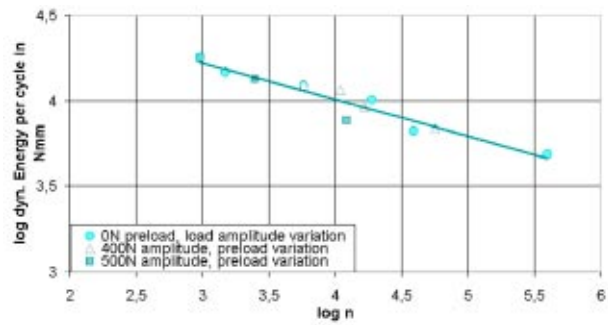


Fig. 3: Energy Dependency on the Fatigue Life of filled EPDM

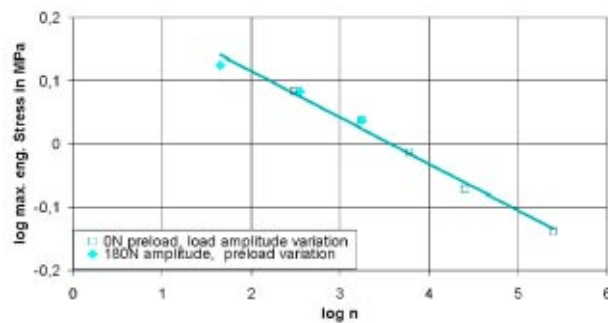


Fig. 4: Maximum Stress Dependency on the Fatigue Life of unfilled EPDM