# Cyclic crack propagation and - arrest in a unidirectional polymer matrix composite exhibiting large scale bridging

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# CRACK PROPAGATION AND -ARREST IN A UNIDIRECTIONAL POLYMER MATRIX COMPOSITE EXHIBITING LARGE SCALE BRIDGING

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## ABSTRACT

Unidirectional laminate double cantilever beam specimens were subjected to mode I fracture in cyclic loading using a novel test setup based on pure bending moments. Crack propagation was studied with the aim of identifying a cyclic cohesive law representing large-scale fiber cross over bridging as a function of the applied load level. It was found that the crack propagation occurred relatively fast in the first load cycles, followed by a transient situation where crack growth rate decreases as a crack bridging zone develops from the initial notch to the crack tip. For loads over a certain threshold, a lower steady state crack growth velocity is attained as the bridging zone is fully developed; then the crack bridging zone propagates along the specimen at the same rate as the crack tip. For loads below this threshold, the crack propagation rate continually decreases and do not reach steady state crack growth. Rates for initial as well as steady state crack growth were determined for a range of external loads. Using a similar approach except with displacement control instead of load control, it has been investigated whether an engineering threshold value exists below which the crack will grow to a certain length where fiber bridging shields the crack tip sufficiently to cause arrest in crack growth. It was shown that such a threshold value does exist and that crack growth caused by cyclic loading below this threshold comes to an apparent stop.

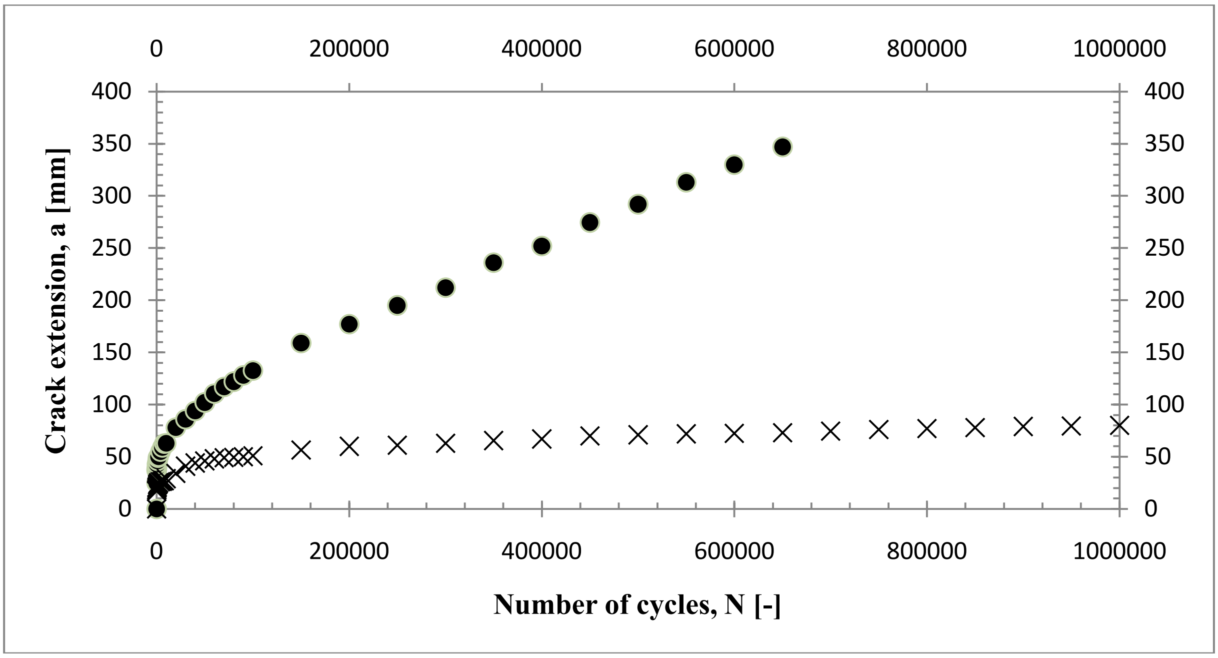


Figure 1: The crack lengths extensions are shown as a function of the number of load cycles for two identical test specimens at different cyclic loads which are pure bending moments at R=0.1. The DCB specimen loaded at the higher bending moment of the two, represented by the dotted marker, clearly shows transient followed by steady state crack growth. The DCB specimen subjected to the lesser load, represented by X'es, also displays transient crack growth, however, it does not reach steady state but rather approaches coming to a halt.

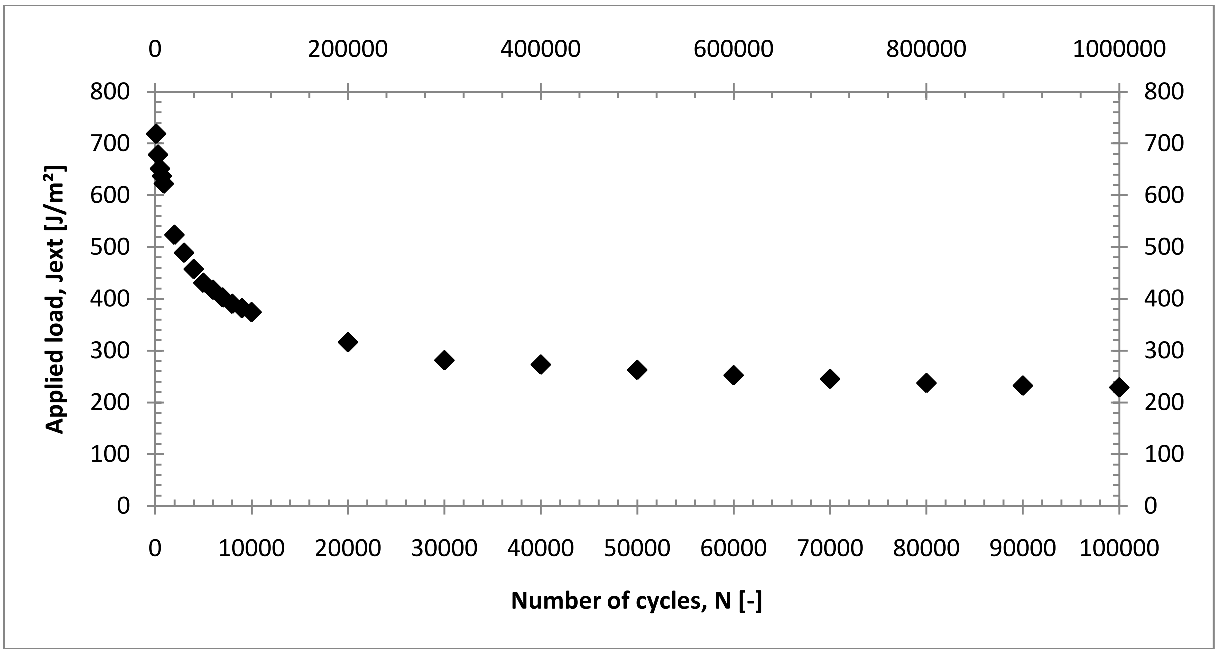


Figure 2: Result of a displacement controlled test showing the max applied load, expressed by the value of the J integral of the applied load, in a load cycle as a function of cycle number. The load initially drops rapidly and levels out as the number of load cycles increases. As crack growth approaches zero the load approaches what can be considered an engineering threshold for cyclic crack growth.