Effects of cyclic ageing on mode I fatigue response of adhesives joint

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Introduction

Effects of the environmental attack on the performance of adhesive joints still attract many attentions. The degradation of the mechanical properties of the adhesive joints by absorption and desorption of the moisture is still concerned [1].

To investigate the degradation of the fatigue performance of an epoxy adhesive under mode I loading condition, Arcan joint samples were manufactured and tested. The absorption and desorption mechanism were conducted in a cyclic ageing process [2]. The aims of the study is to find the effects of the ageing cycles on the fatigue response of the tested adhesive.

Experimental methodology

To investigate the fatigue strength of the adhesive under mode I loading condition, an Arcan joint was manufactured (see Fig. 2). To perform ageing and drying process, the Arcan joints were immersed in distilled water following different ageing cycles (see Fig. 3). Then Arcan joints were tested usaing an Arcan testing apparatus (see Fig. 4).

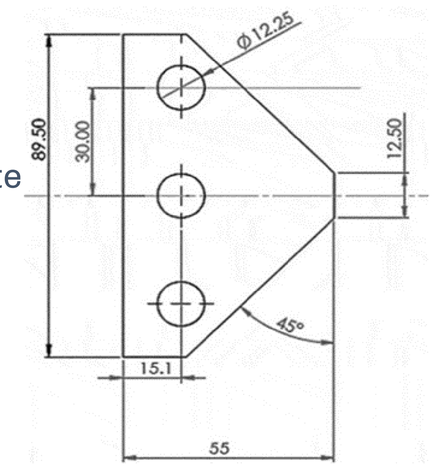

Figure 1 – Arcan substrate (only half is presented)

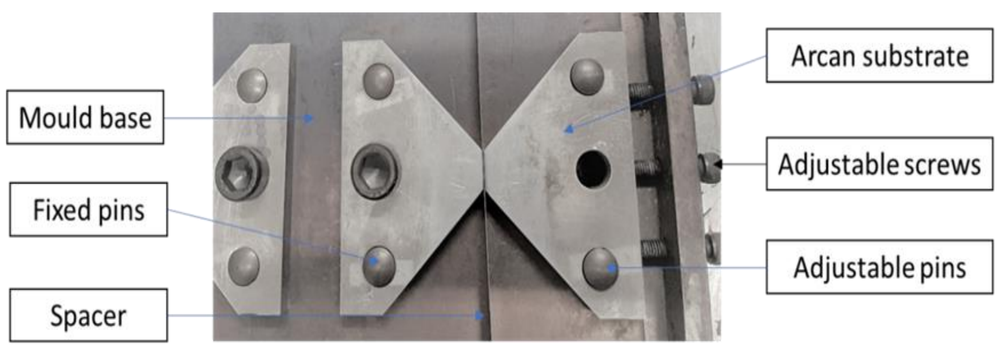

Figure 2 – Arcan joint manufacturing

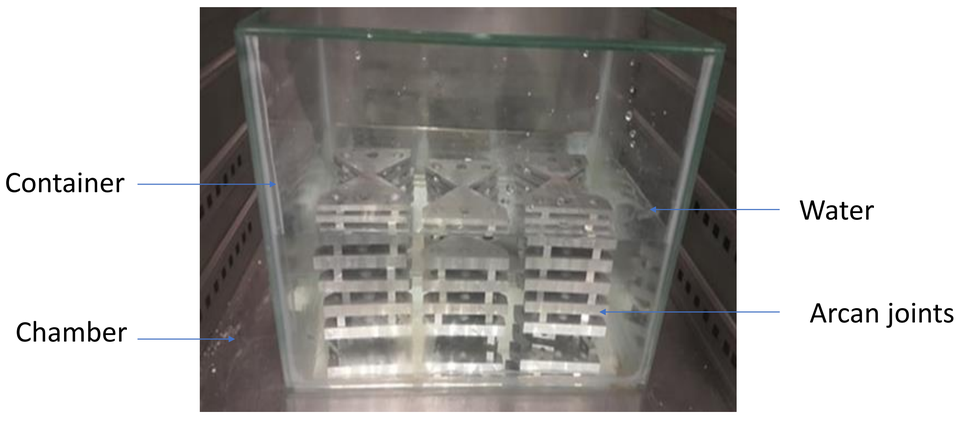

Figure 3 – Ageing of Arcan joints

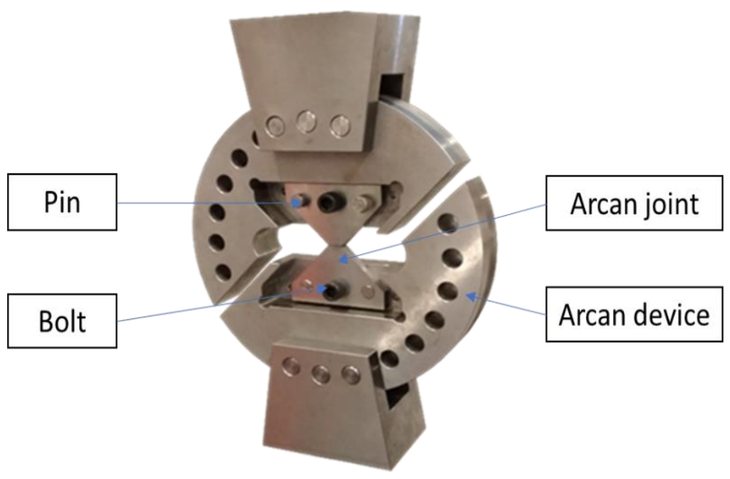

Figure 4 – Arcan testing assembly

Experimental results

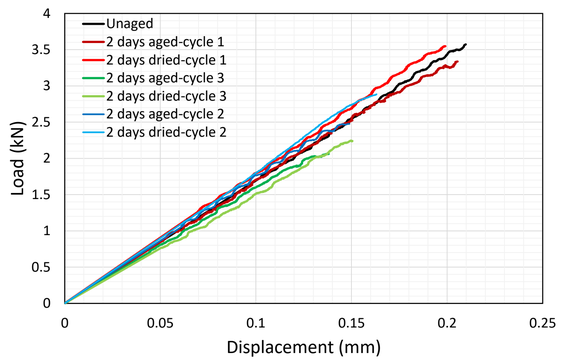

Figure 5 – Typical load-displacement curves Arcan joint for 2 days ageing cycles

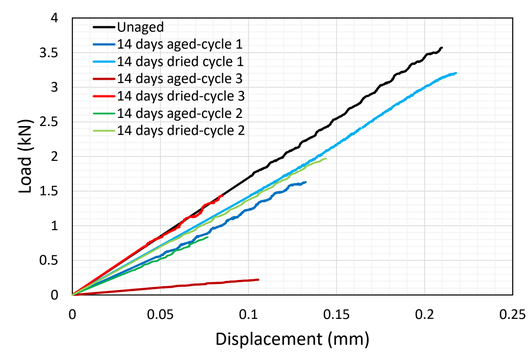

Figure 6 – Typical load-displacement curves Arcan joint for 14 days ageing cycles

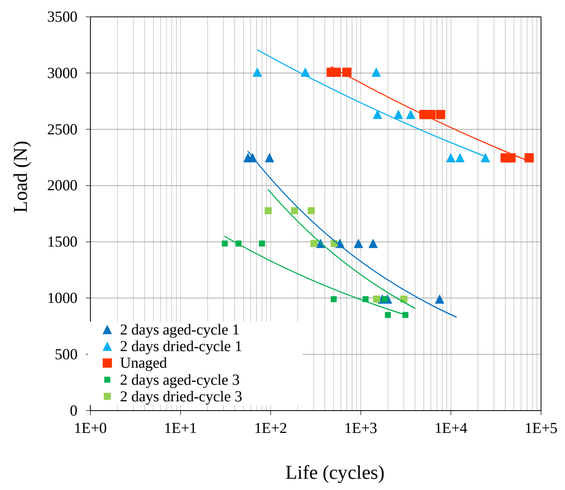

Figure 7 – The L-N curve of joints for 2 days ageing cycles

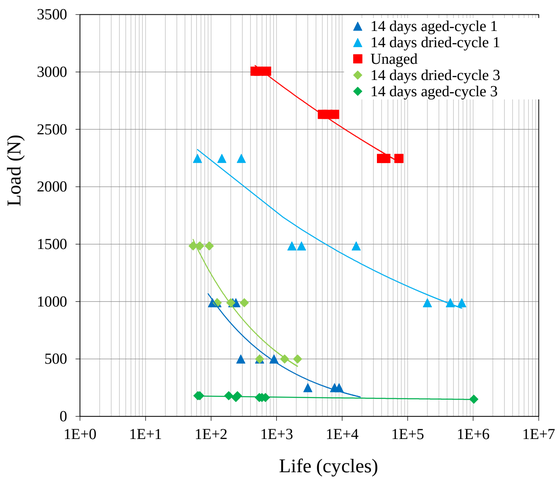

Figure 8 – The L-N curve of joints for 14 days ageing cycles

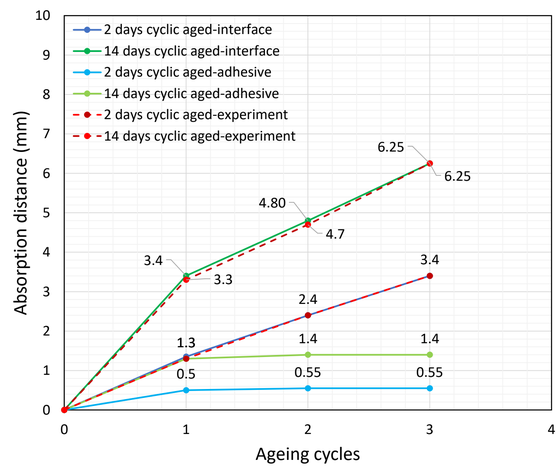

Figure 9 – The length of water ingress as a function of ageing cycle

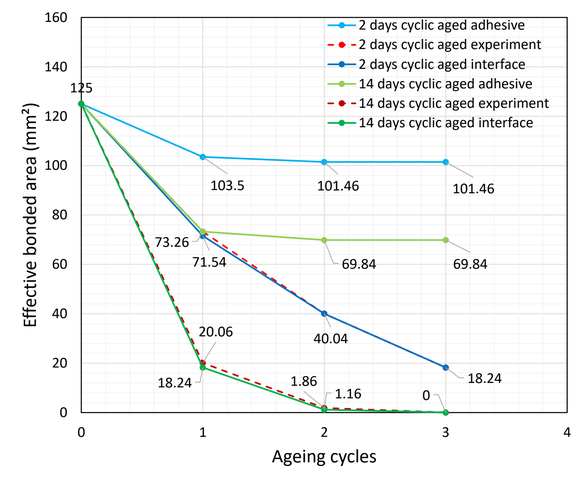

Figure 10 – Remaining effective bonded area as a function of ageing cycle

Conclusions

The static and fatigue strength of adhesive joints are greatly affected by a repeated moisture absorption and desorption process. The tensile properties and the fatigue life of the joints were degraded by ageing cycles. The degradation of the joint is significantly affected by interfacial ageing.

The performance of the static and fatigue of the joints were partially recovered following a drying process. The simulation of water absorption of adhesive joints, showed that the water diffusion becomes faster by increasing the ageing time and cycles. Results also showed that the fatigue life is significantly decreases by increasing the number of ageing cycles and by increasing the ageing time at each cycle.

References

[1] Viana, G., et al., *Behaviour of environmentally degraded epoxy adhesives as a function of temperature.* The Journal of Adhesion, 2017. **93**(1-2): p. 95-112.

[2] Machado, J., et al., *Effect of hygrothermal aging on the quasi-static behaviour of CFRP joints varying the overlap length.* Composite Structures, 2019. **214**: p. 451-462.