Effects of the ageing level on mode I fatigue life of adhesives

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Introduction

Aggressive environments can drastically reduce the durability of bonded structures [1]. Despite the extensive research on the static performance of aged adhesives, a few works have been published on the influence of ageing on the fatigue response of the bonded structure. The aim of the current work is to analyse the effects of ageing level on the mode I fatigue life of a structural epoxy based adhesive. To achieve this Arcan joint were manufactured, aged, and fatigue tested in pure mode I loading conditions.

Experimental methodology

Arcan sample (see Figure 1) used in this study to evaluated the mode I fatigue response of the adhesive. To manufacture the joints a specific mould was employed as shown in Figure 2. To perform the ageing and drying processes, the Arcan joints were immersed in distilled water (see Figure 3). The joints were taken out of the water at specific ageing times. Joint were tested using an Arcan device as shown in Figure 4.

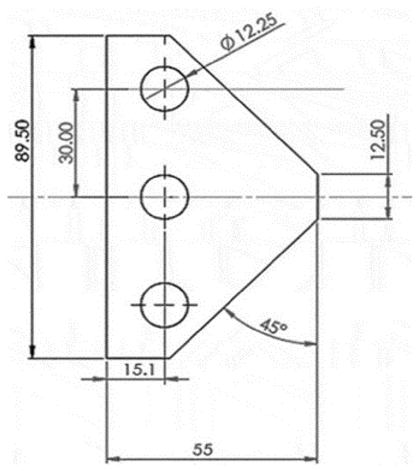

Figure 1 – Arcan substrate

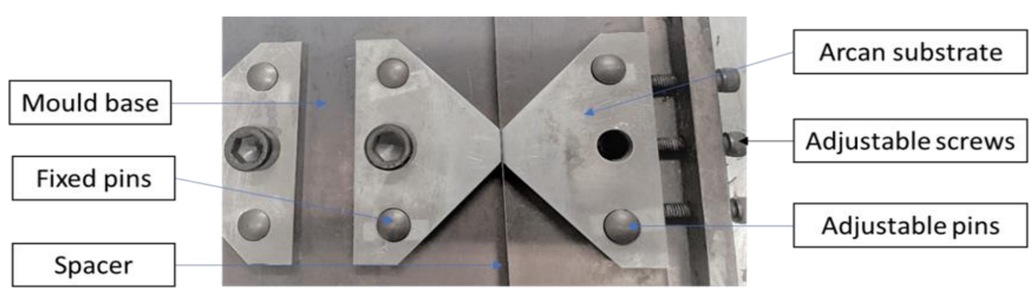

Figure 2 – Arcan joint manufacturing

Figure 3 – Ageing of the Arcan joints

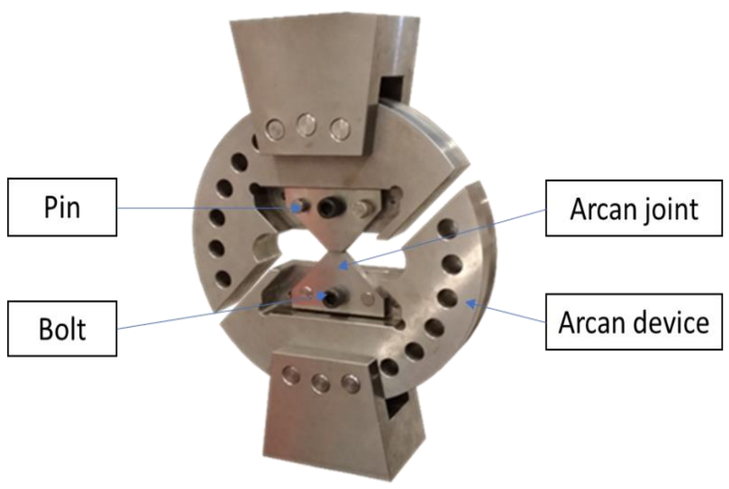

Figure 4 – Arcan testing device

Experimental results

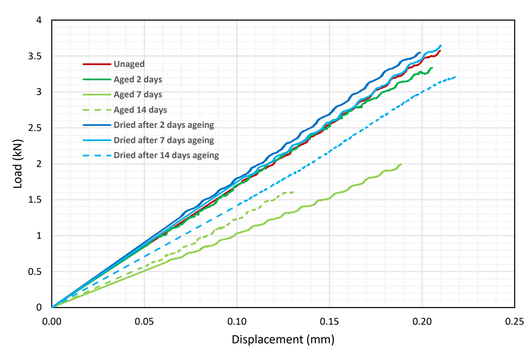

Figure 5 –Typical load-displacement curve of Arcan joints for different ageing conditions.

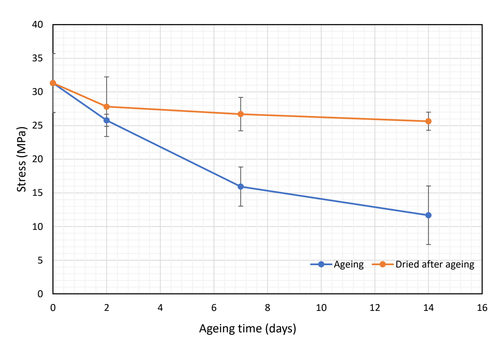

Figure 6 –Static strength as a function of the ageing level

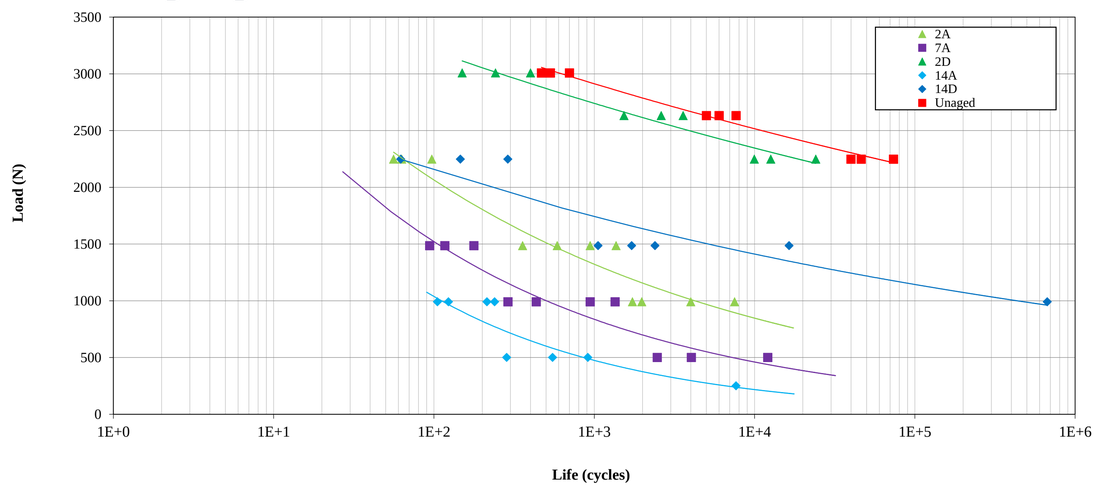

Figure 7 –L-N fatigue curve of the Arcan joints for different ageing conditions

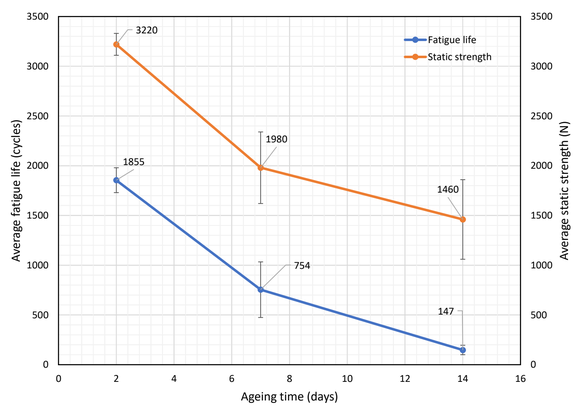

Figure 8 – Comparisons of the degradation in the static strength and the fatigue life for aged Arcan samples

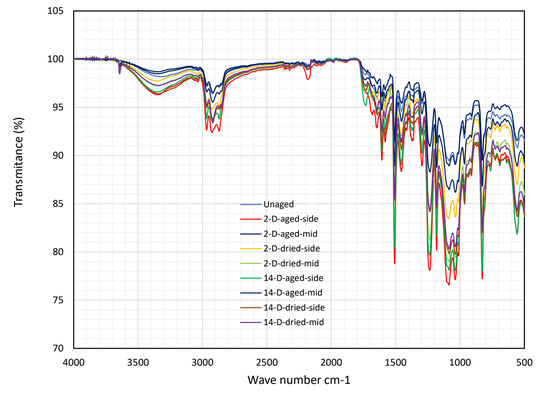

Figure 9 – FTIR analysis of the aged and unaged Arcan joints

Conclusions

The static strength and the fatigue life of the adhesive joints are significantly influenced by the ageing process (both the moisture absorption and desorption). The mechanical properties and the fatigue life of the joints degraded by the ageing levels. The reduction in fatigue life for the aged samples is a function of the ageing level. Adhesive properties degradation, reduction of the effective bonding areas due to the interfacial ageing, and the increase in the stress concentration due to the change in the angle between the adhesive and substrates at overlap ends, are the main reasons that cause a significante drop in the durability of the joints subjected of wet environments.

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.