Effects of the cyclic ageing on tensile performance of adhesives joint

J.A da Costa (FEUP, Portugal), A. Akhavan-Safar, E.A.S Marques, R.J.C Carbas, L.F.M da Silva

Advanced Joining Processes Unit

Introduction

The ability of the adhesive to absorb moisture in the surrounding environment is neglectable. The effects of the moisture absorption and desorption to the mechanical properties degradation of the adhesive joints still needs further research. To predict the reduction of the tensile properties of an epoxy adhesive under tensile loading condition, Arcan joint samples were manufactured and tested under tensile stresses. To conduct the hygrothermal ageing, the cyclic ageing mechanism was used to perform the absorption and desorption process [1, 2]. The objective of the study is to find out the effects of the ageing cycles on the tensile performance of the adhesive.

Experimental methodology

To predict the tensile strength of the adhesive under tensile loading condition, an Arcan joint was manufactured (see Fig. 2). To conduct the repeated ageing process, the Arcan joints were immersed in distilled water following different ageing cycles (see Fig. 3). Furthermore, tensile tests were performed on the aged Arcan joints by using an Arcan testing device (see Fig. 4).

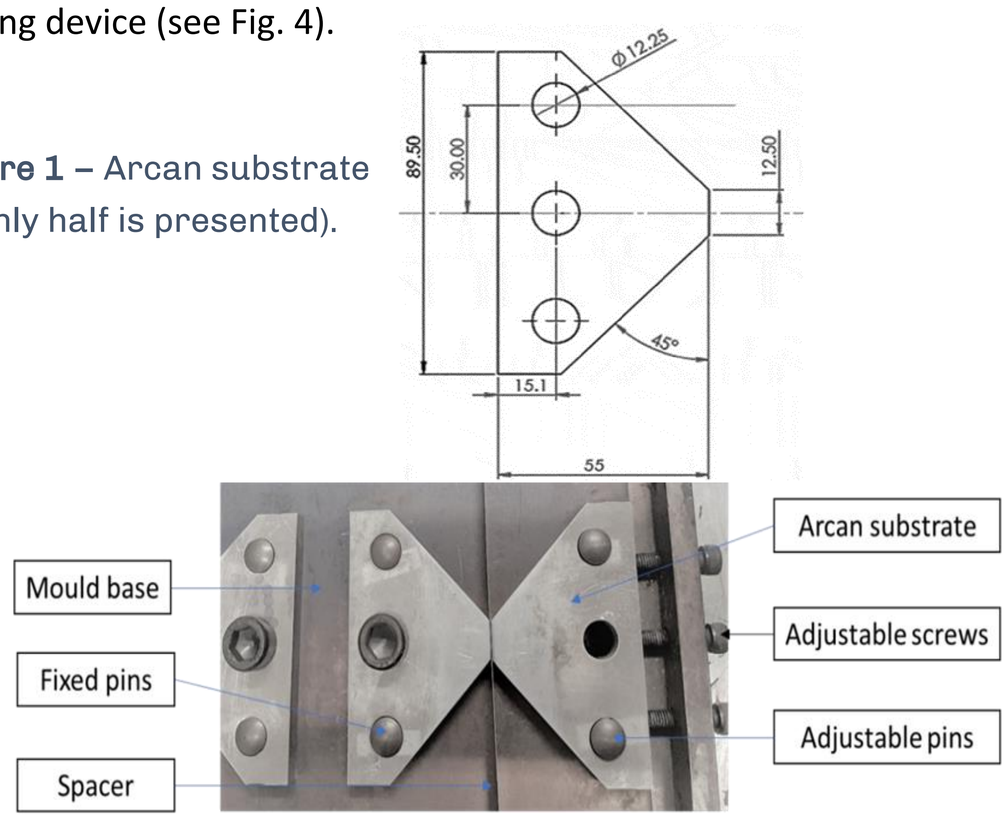

Figure 1 – Arcan substrate (only half is presented).

Figure 2 – Arcan joint manufacturing.

Figure 3 – Arcan joint ageing.

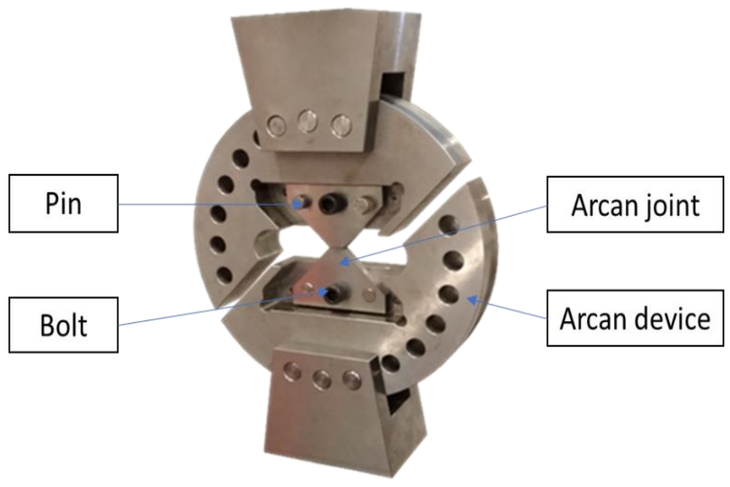

Figure 4 – Arcan testing device.

Experimental results

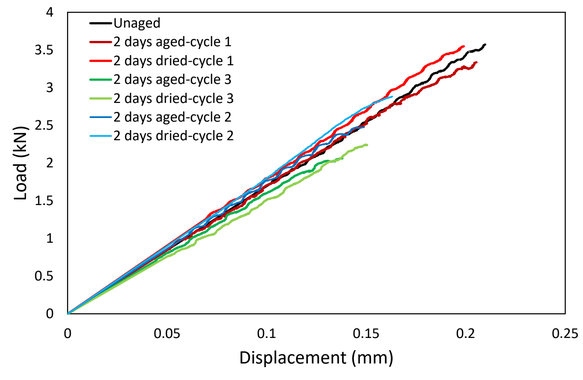

Figure 5 – Typical load-displacement curves of Arcan joint for 2 days ageing cycles

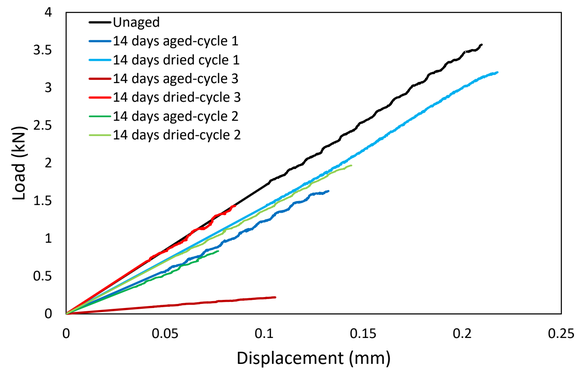

Figure 6 – Typical load-displacement curves of Arcan joint for 14 days ageing cycles

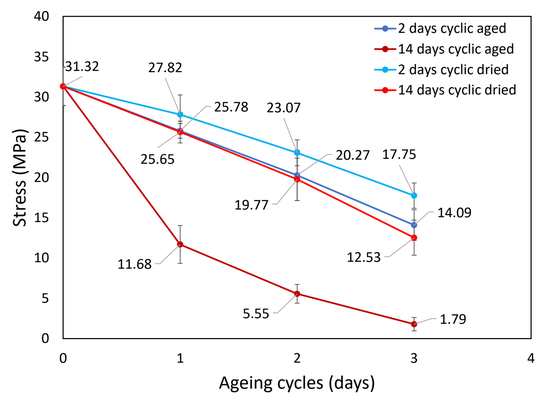

Figure 7 – Strength as a function of ageing cycles for 2 days and 14 days ageing cycles

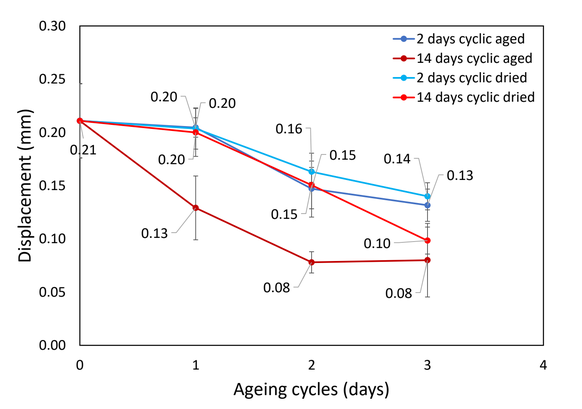

Figure 8 – Displacement as a function of ageing cycles for 2 days and 14 days ageing cycles

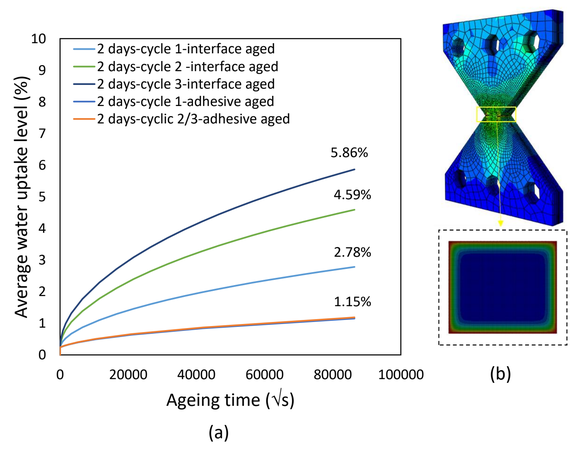

Figure 9 – Average water uptake level of joints with 2 days cyclic ageing. (a) Adhesive and interface, (b) Analysis model

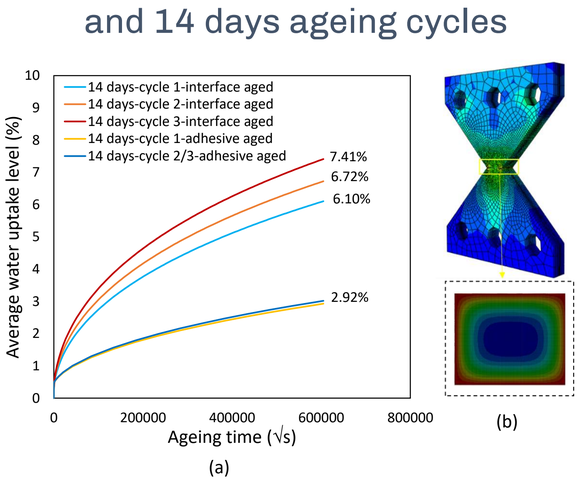

Figure 10 Average water uptake level of joints with 14 days cyclic ageing. (a) Adhesive and interface, (b) Analysis model

Conclusions

The tensile strength of the tested epoxy adhesive is significantly affected by moisture absorption and desorption. The mechanical properties under the tensile load condition were degraded by ageing cycles.

Joint degradation is significantly influenced by interfacial ageing. The tensile properties of the aged joints were partially recovered by the drying process. However, the tensile properties do not return to the initial stage as an unaged condition with respect to bond strength deteriorations at the interface. Increasing the period of each cycle increase the rate of degradation of the tensile strength of the joints. The simulation results showed that more water was absorbed through the adhesive joint interface, rather than the adhesive layer.

References

[1] Barbosa, et al., *Hygrothermal aging of an adhesive reinforced with microparticles of cork*. The Journal of Adhesion Science and Technology, 2015. 29:16, 1714-1732.

[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.