The interaction of mode mixity and humidity on the S-N response of an epoxy adhesive

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Introduction

Although, a large number of studies has been carried out to assess the behaviour of bonded joints subjected to humidity and different loading conditions [1, 2], determining the rate of property degradation for aged samples as a function of loading type/angle has not yet been carried out. Accordingly, the aim of the current study is to better understand how the loading angle affects the properties of an adhesive under hygrothermal ageing. For thus purpose, an epoxy adhesive was subjected to different loading angles, including standard strength tests, fracture tests, static Arcan tests and S-N experiments using Arcan joints.

Experimental methodology

A two-component epoxy based structural adhesive was used to study the effect of temperature and load angle on the fatigue response of Arcan joints.

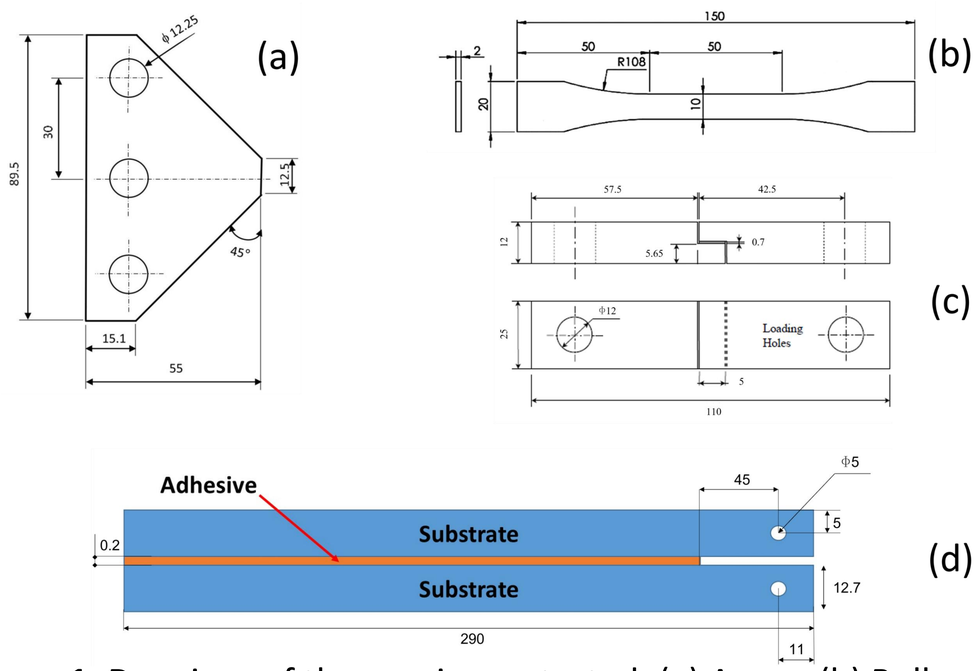


Figure 1: Drawings of the specimens tested; (a) Arcan, (b) Bulk dogbone, (c) TAST, and (d) DCB/ENF, (dimensions in mm)

Test	Temperature
Tensile bulk test	Room temperature
	50 °C
TAST	Room temperature
	50 °C
DCB, mode I	Room temperature
	50 °C
ENF, mode II	Room temperature
	50 °C

Static		Fatigue	
Mode mixity	**Temperature**	**Mode mixity**	**Temperature**
Mode I	Room temperature	Mode I	50 °C
	50 °C		
Mode II	Room temperature	Mode II	50 °C
	50 °C		

Results and Discussions

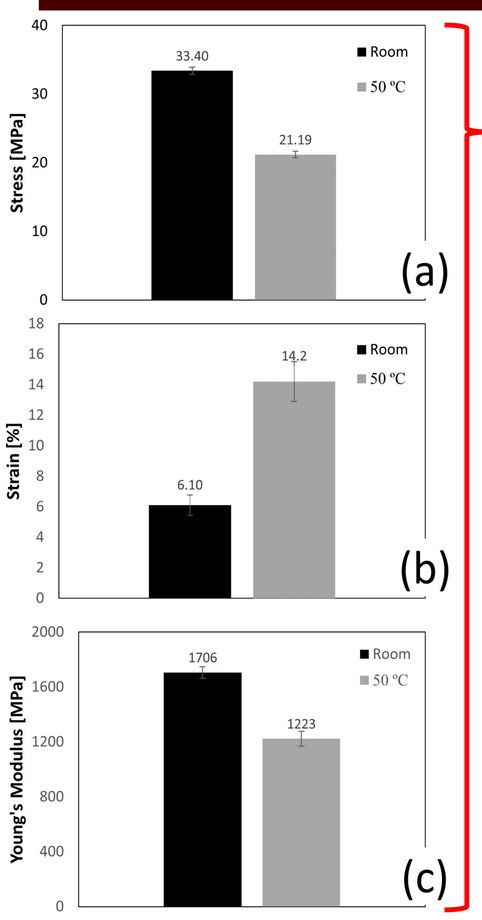


Figure 2 - Figure 3: Effect of temperature on the tensile properties

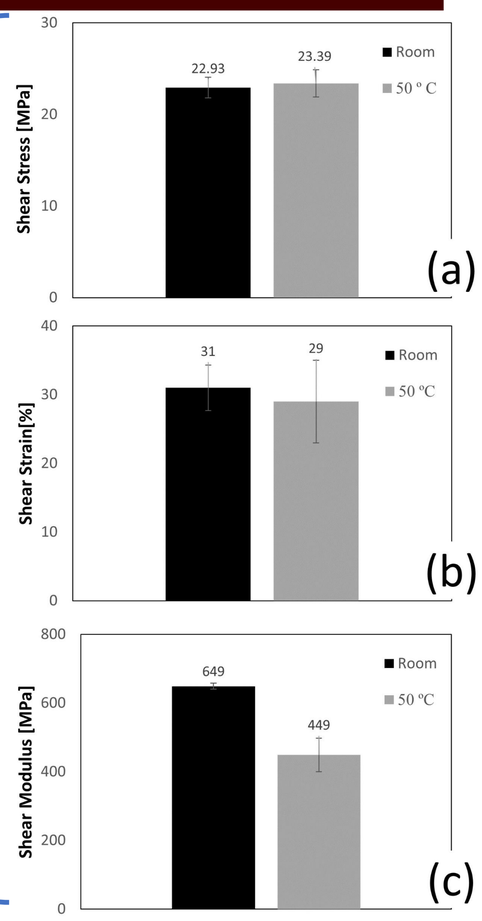


Figure 3 - Figure 3: Effect of temperature on the shear properties

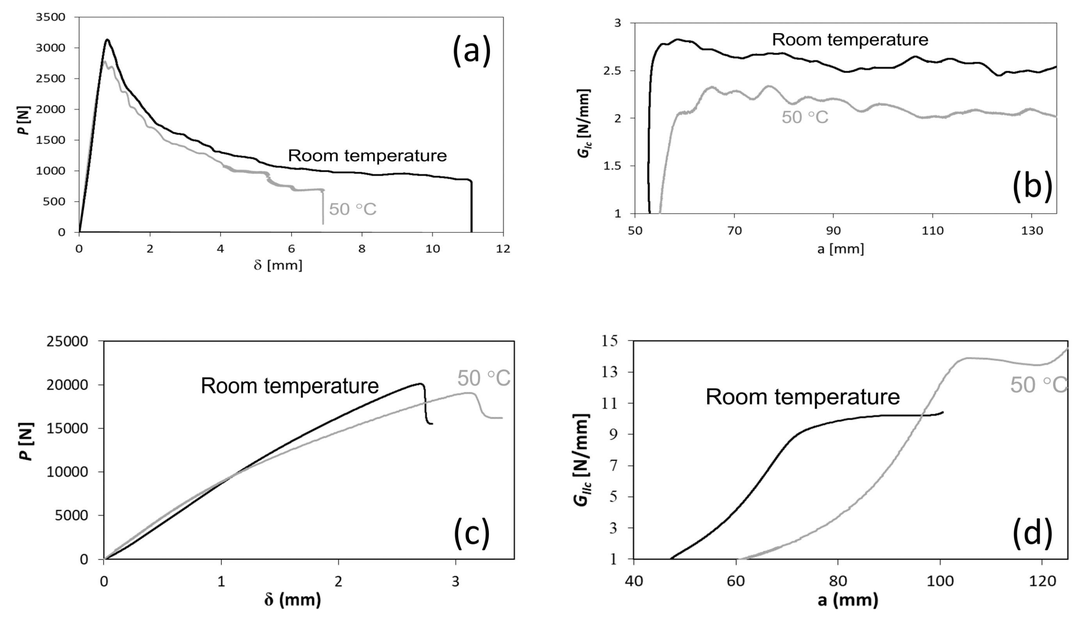
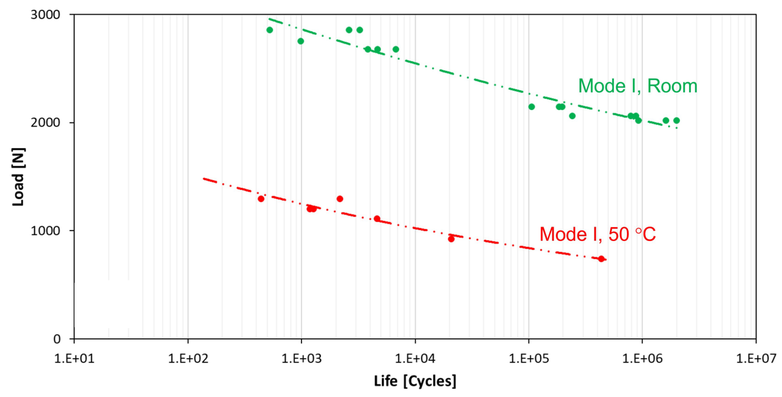


Figure 4 – Mode I [(a) and (b)] and mode II [(c) and (d)] results for room temperature and 50°C.

Figure 5: S-N curves for room temperature vs. 50 °C, mode I



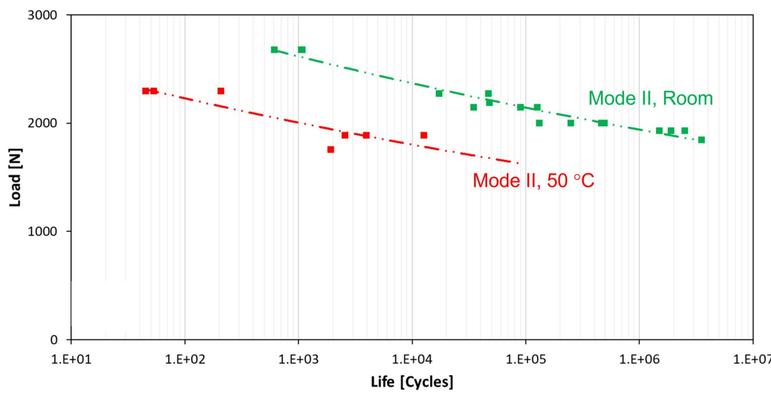


Figure 6: S-N curves for room temperature vs. 50 °C, mode II

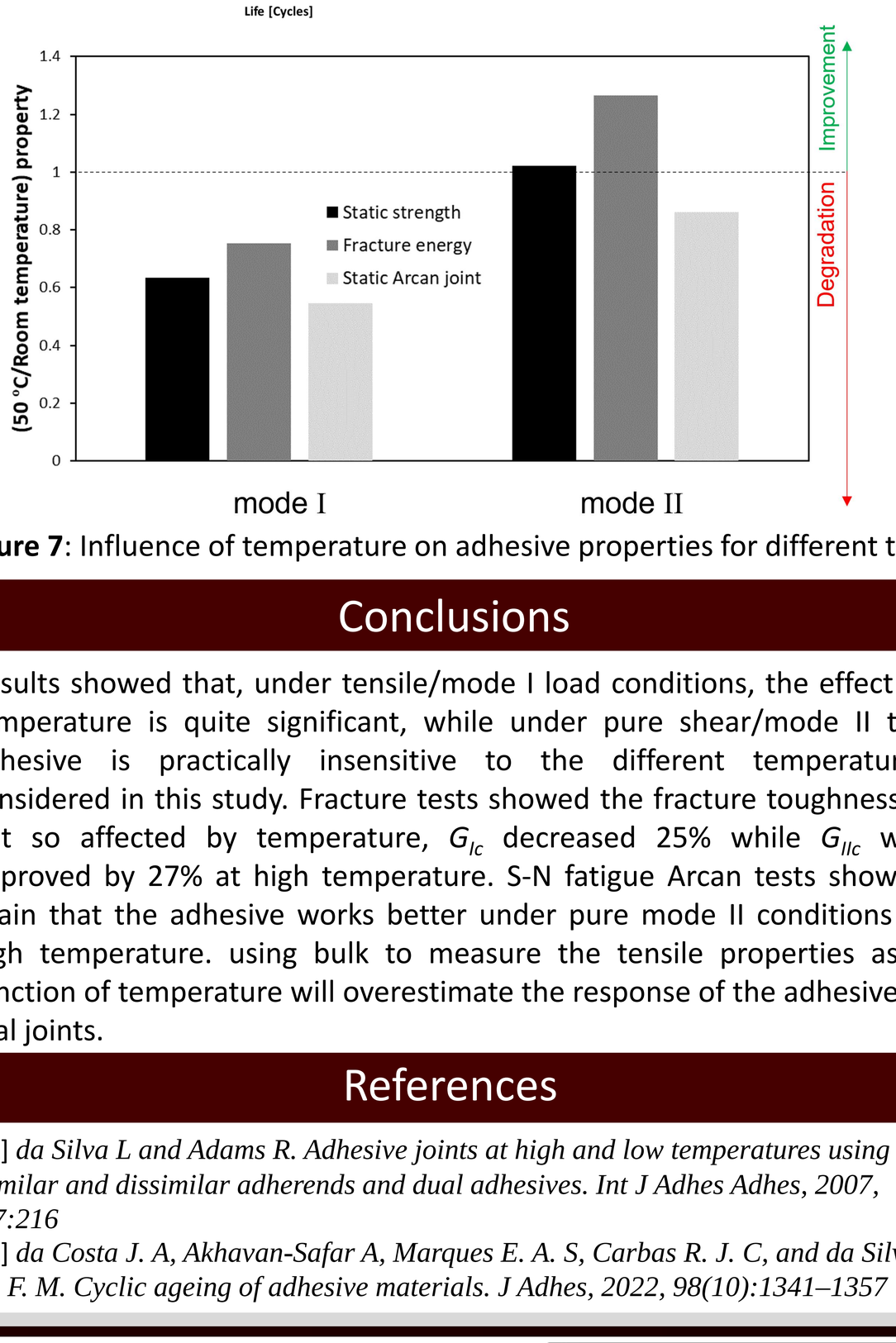


Figure 7: Influence of temperature on adhesive properties for different tests

Conclusions

Results showed that, under tensile/mode I load conditions, the effect of temperature is quite significant, while under pure shear/mode II the adhesive is practically insensitive to the different temperatures considered in this study. Fracture tests showed the fracture toughness is not so affected by temperature, G_{Ic} decreased 25% while G_{IIc} was improved by 27% at high temperature. S-N fatigue Arcan tests showed again that the adhesive works better under pure mode II conditions at high temperature. using bulk to measure the tensile properties as a function of temperature will overestimate the response of the adhesive in real joints.

References

[1] *da Silva L and Adams R. Adhesive joints at high and low temperatures using similar and dissimilar adherends and dual adhesives. Int J Adhes Adhes, 2007, 27:216*

[2] *da Costa J. A, Akhavan-Safar A, Marques E. A. S, Carbas R. J. C, and da Silva L. F. M. Cyclic ageing of adhesive materials. J Adhes, 2022, 98(10):1341–1357*