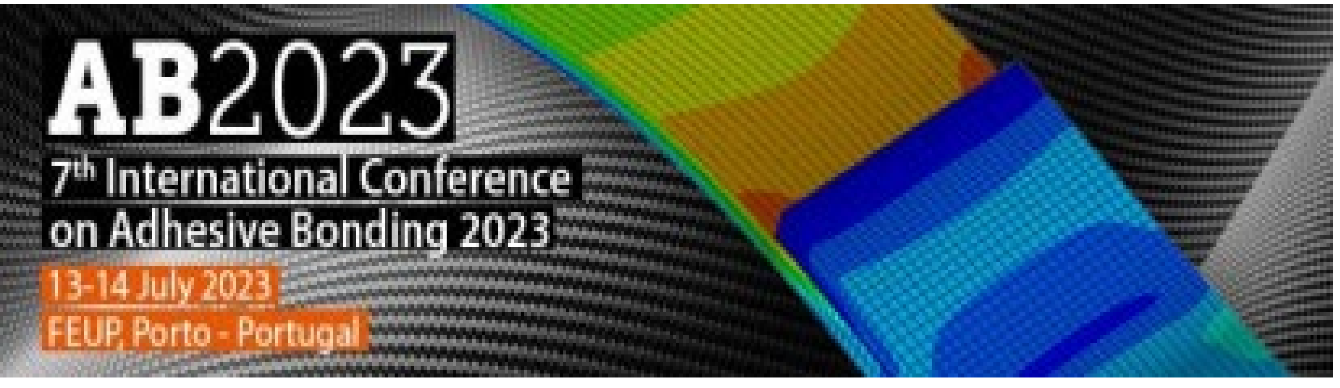

Experimental validation of the characterisation of highly flexible adhesive using DCB bonding

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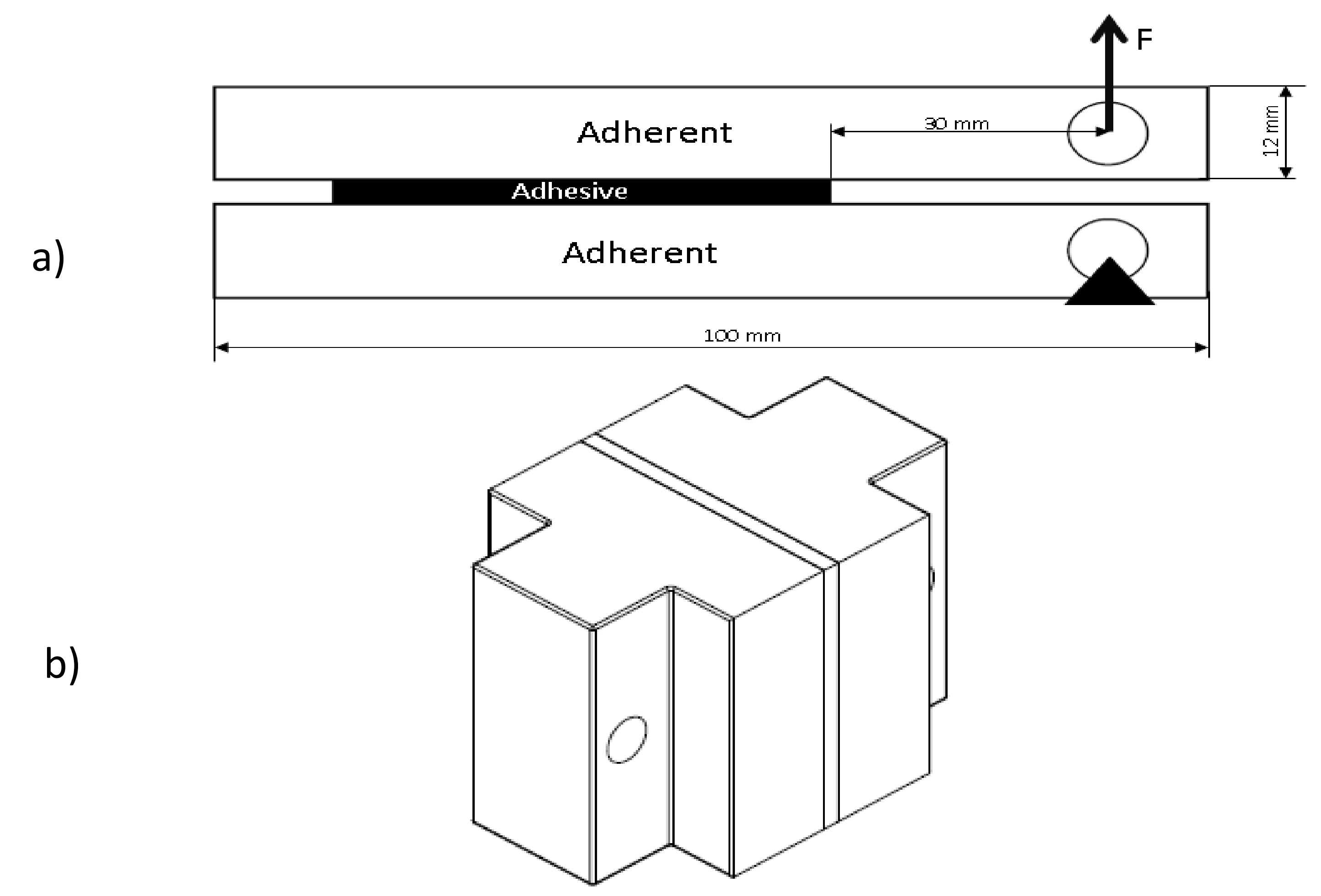
INTRODUCTION AND OBJECTIVES

The main objective of this research is to verify the accurate mechanical characterisation of an adhesive with hyperelastic behaviour in joints subjected to different types of stresses. In this case, the hyperelastic behaviour laws of the adhesive have been previously determined and validated by means of the Single Lap Joint (SLJ) test only, performed by the research group. As a result, it was determined that the Mooney Rivlin model provides the best fit for the adhesive. This work is divided into two parts. In the first part, an experimental analysis of the behaviour of the adhesive under tearing is performed using the Double Cantilever Beam (DCB) specimen configuration (fig. 1.a). In the second part, the behaviour of the adhesive under tensile stress is investigated using the T-shaped specimen (fig. 1.b). It is analysed how this behaviour varies as a function of the adhesive thickness. The second part focuses on the experimental validation of the bond by subjecting the adhesive to tearing, using the DCB type of specimen, and the adhesive law based on the Mooney Rivlin model. In order to verify the main objective of this research, the results of the SLJ shear and DCB peel tests have been compared with the data obtained in the simulations. This will enable modelling with more evidence of final joints, which will provide detailed information on the stress and strength distribution in each case, in order to achieve more efficient joints.



Fig, 1. DCB tearing test tube (a), T-tensile test tube (b).

RESULTS AND EXPERIMENTAL DISCUSSION

In this section, the results of the quasi-static tests carried out are presented and analysed. Tear tests were carried out using double cantilever beam (DCB) specimens with adhesive thicknesses of 2, 3, 4 and 6 mm. Tensile tests were also carried out using the T-probe configuration, with adhesive thicknesses of 4 and 6 mm. After the tests, cohesive failure was observed in all cases.

Fig. 2. shows the force-displacement curves corresponding to the DCB tests in relation to the adhesive thickness. It can be seen that as the adhesive thickness decreases, the slope of the curves increases, indicating that the bond stiffness increases progressively. For the DCB specimen configuration of adhesive thickness 2, 3 and 4 mm the load increased almost linearly with the displacement in the initial phase.

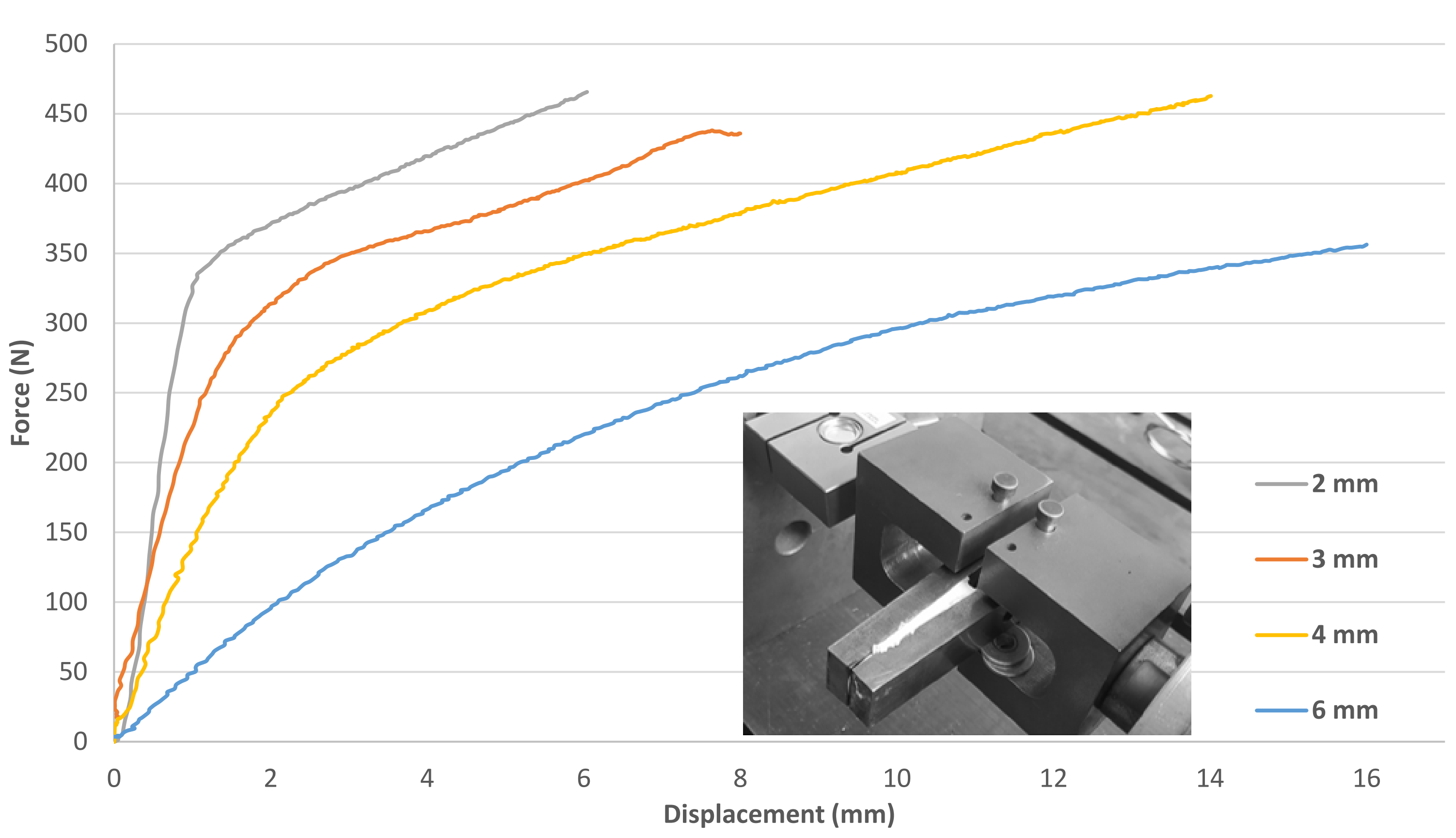


Fig. 2. Experimental results for DCB joint 2-3-4-6 mm.

Fig. 3. shows the force-displacement curves corresponding to the tensile tests made with 4 and 6 mm adhesive thickness. In this case, it is also observed that as the adhesive thickness decreases, the slope of the curves has slightly increased. In the case of the 6 mm thick adhesive bond, failure occurs at a higher displacement compared to the thinner adhesive.

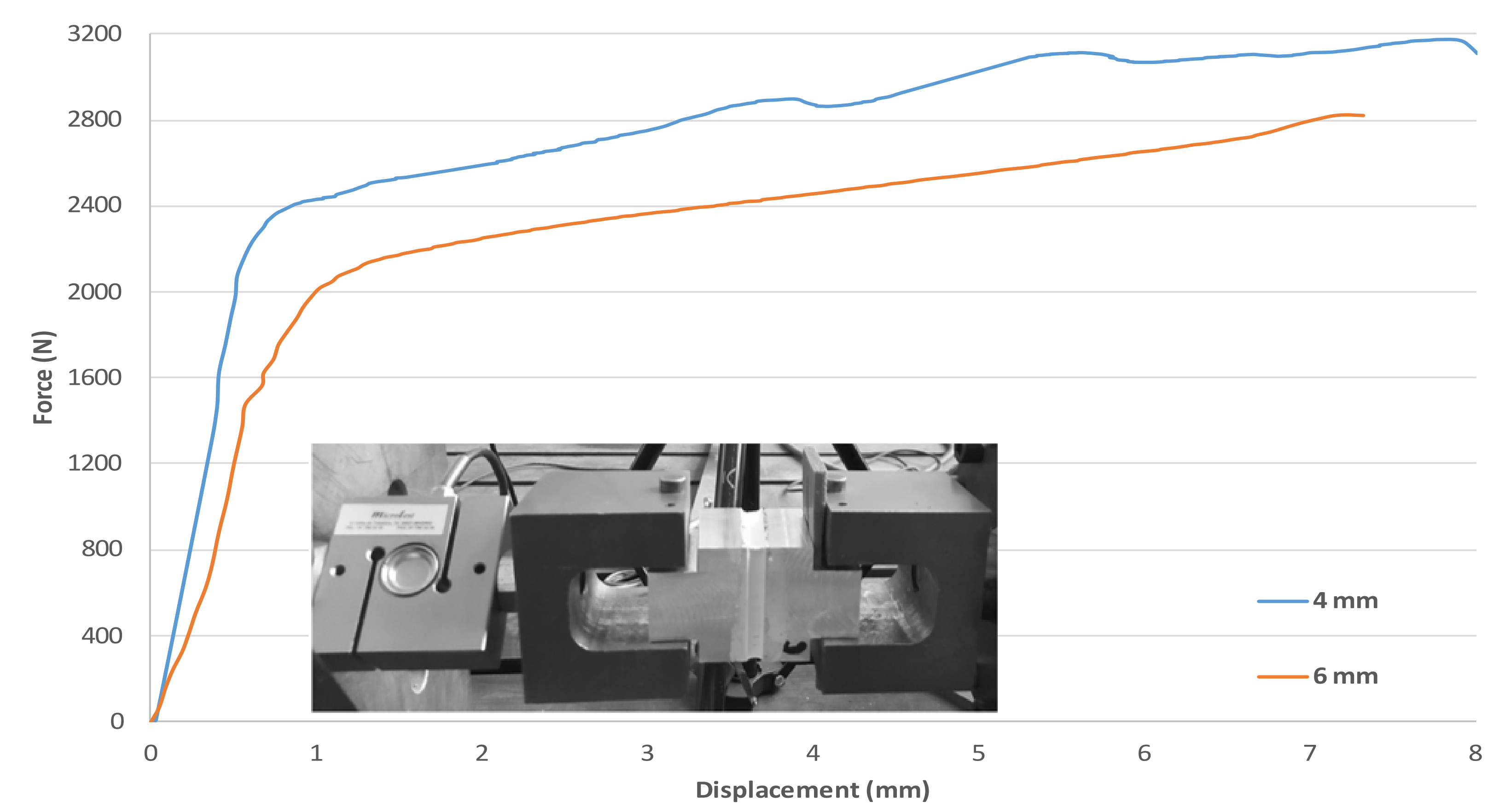


Fig. 3. Experimental results for tensile bond 4-6 mm.

EXPERIMENTAL VALIDATION

This last part focuses on the experimental validation of the bond by subjecting the adhesive to tearing, using the DCB specimen type with adhesive thicknesses 4 and 6 mm, and the adhesive law based on the Mooney Rivlin model (fig. 4). This aims to assess the accuracy and validity of the adhesive characterisation, verifying whether the model is able to accurately predict the adhesive behaviour in the bond under different loads.

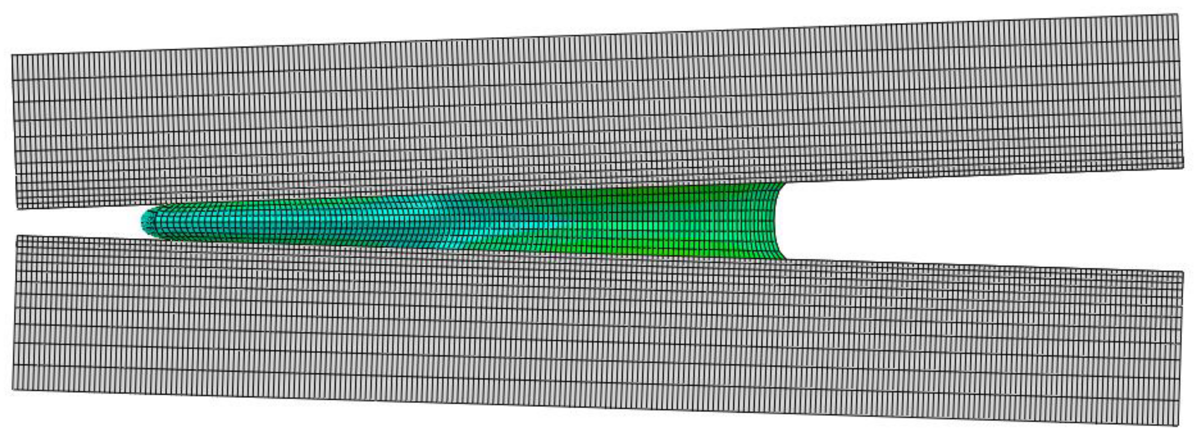


Fig. 4. FE simulation DCB.

The results obtained from the simulation show an acceptable correlation with the experimental results in both cases of specimens. This indicates that the Mooney-Rivlin model used is adequate for defining the behaviour of the adhesive under tearing loads, up to the stages prior to adhesive fracture. Going deeper into each of the configurations, as can be seen in Fig. 5, the slope of the experimental and numerical curves are very similar in each of them.

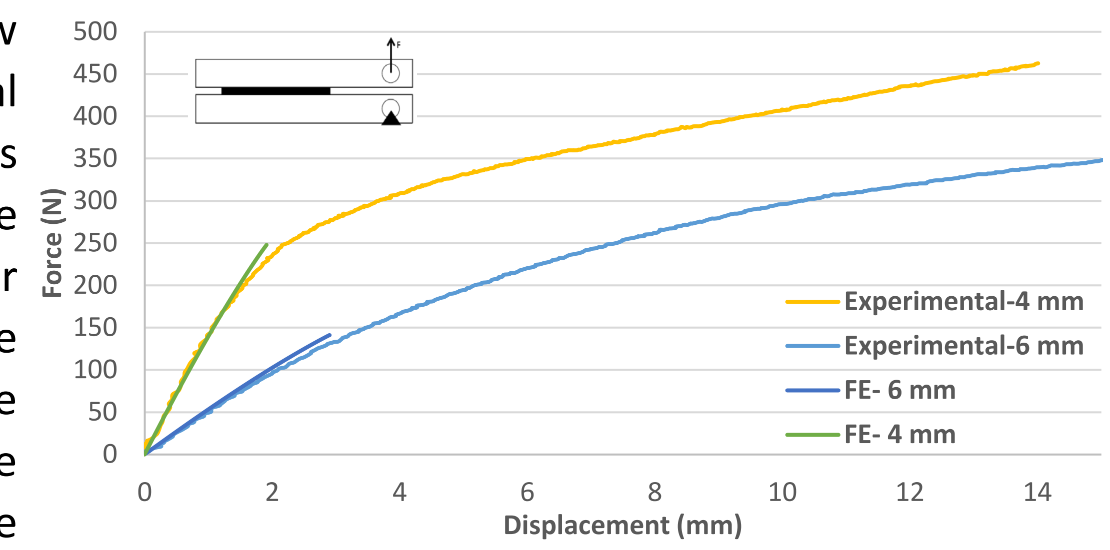


Fig. 5. FEM-experimental validation.

CONCLUSIONS AND FUTURE LINES OF ACTION

After analysing the results of both the present research and previous work of the research group, we can consider that the mechanical characterisation of the adhesive has been satisfactorily concluded. The results obtained provide a solid understanding of the behaviour of the adhesive under different loading conditions and adhesive thicknesses.

The mechanical characterisation of the adhesive at high temperatures and the fracture characterisation of the high flexibility adhesive are proposed as future lines of work. These lines of work will contribute to improve the understanding of adhesives in different scenarios and to develop more efficient solutions adapted to different conditions of use.

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