# The performance of composite adhesive joints reinforced with thin-ply

R.C.J. Carbas (INEGI, Portugal), F. Ramezani, E.A.S. Marques, L.F.M. da Silva

ADVANCED JOINING PROCESSES UNIT

## Introduction

This study investigated the behavior of different composite laminates thickness (conventional carbon fiber reinforced polymer (CFRP) and thin-ply) in a single lap joint [1]. Three different configurations were considered, using only CFRP, only thin-ply and a combination of CFRP reinforced by thin-ply. The joints were tested experimentally under different rates in order to understand the influence of test rate. A numerical analysis was carried out to enable a more precise understanding of how the strain rate influences the performance of reinforced adhesive joints and its associated failure mechanism.

.

## Experimental methodology

**Adhesive**

Scotch Weld AF 163-2k – film-form modified epoxy adhesive.

**Adherend**

Texipreg HS 160 T700 – unidirectional prepreg carbon-epoxy with a ply thickness of 0.075 mm.

NTPT-TP415 – unidirectional prepreg carbon-epoxy with a ply thickness of 0.075 mm

**Joint geometry**

Figure 1 illustrates the geometry of the specimen used and schematic design of adherend considered.

**Testing conditions**

Instron 8801 servo hydraulic testing machine with a load cell of 100 kN, at a constant crosshead speed of 1 mm/min and 0.1 m/sec for static and high-rate loading respectively. A drop weight machine with 50 kg mass and an impact velocity of 2 m/s were chosen, resulting in an impact energy of 100 J was used.

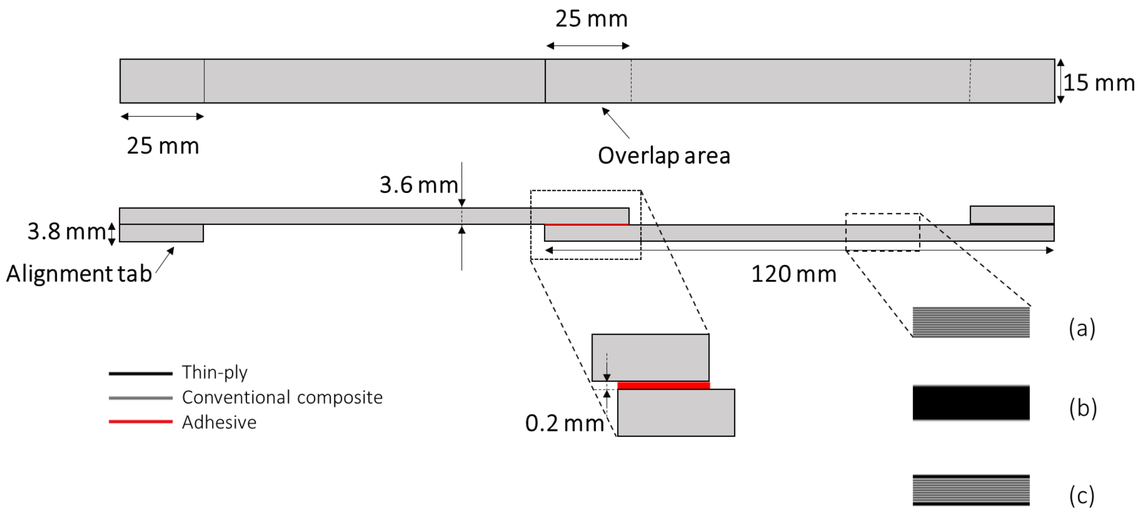


Figure 1 – Schematic design of (a) conventional composite, (b) thin-ply, and (c) hybrid joint (25% thin-ply) joint

## Experimental results

Figure 2 shows that the hybrid (25% thin-ply) joint presented the highest failure load under all loading conditions. An increase in joint strength for hybrid (25% thin-ply) joint was observed compared to the reference conventional composite configuration under static loading.

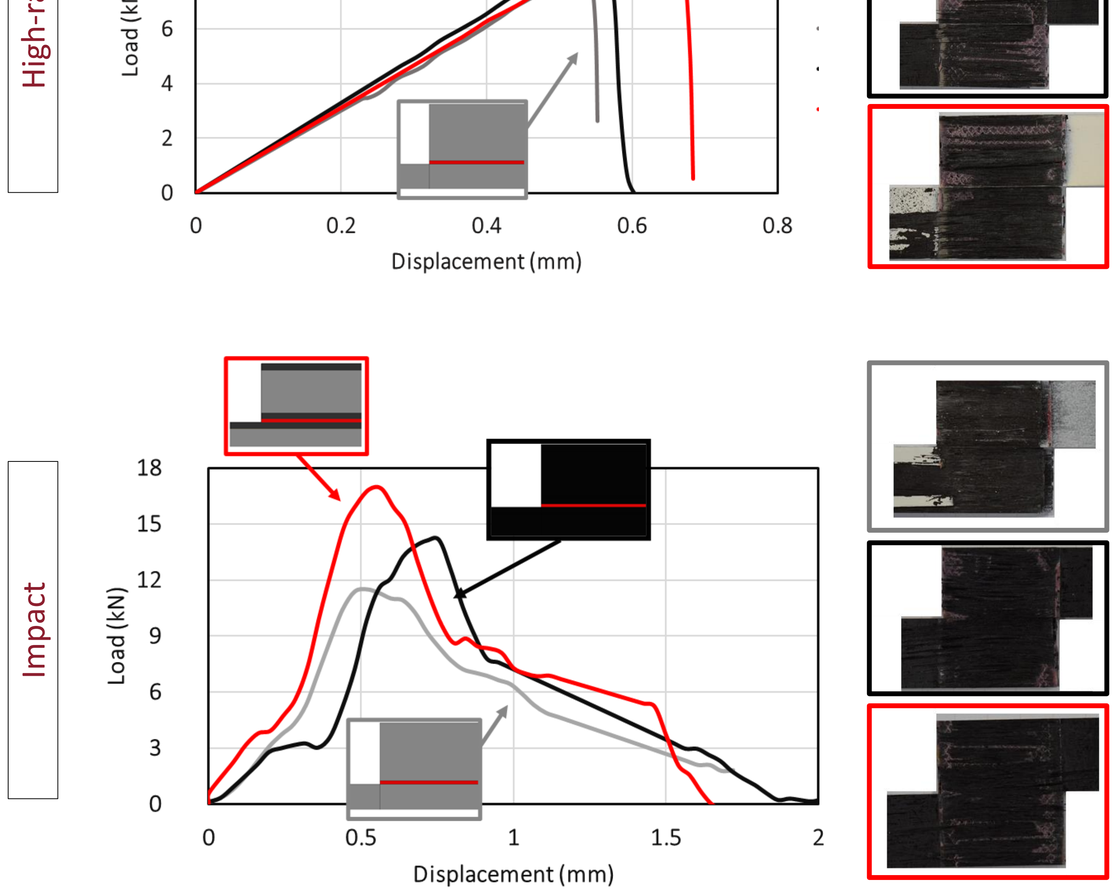


Figure 2 – Load-displacement of composite joint under different loading

## Conclusions

- An increase in the failure load was found for the hybrid joint reinforced by thin-ply, when compared to the reference conventional composite joint, more pronounced for quasi-static conditions.
- The most limited amount of delamination obtained was for the hybrid joints under static loading.
- Increasing the strain rate, the failure mechanism is caused by delamination, caused by the low performance of this type of composite under high rates and low peel strength.
- The adherend need to be reinforced with a though external layers in order to obtain an adherend strain rate dependent.

## References

[1] Ramezani, F., Carbas, R.J., Marques, E.A., Ferreira, A.M. and da Silva, L.F., 2023. A study of the fracture mechanisms of hybrid carbon fiber reinforced polymer laminates reinforced by thin-ply. Polymer Composites, 44(3), pp.1672-1683.

## Acknowledgements

The authors gratefully acknowledge the Portuguese Foundation for Science and Technology (FCT) for supporting the work presented here, through the individual grant's CEECIND/03276/2018 and 2021.07943.BD, and the Project No. PTDC/EME-EME/2728/2021.

U.PORTO FEUP FACULDADE DE ENGENHARIA UNIVERSIDADE DO PORTO

inegi driving science & innovation

FCT Fundação para a Ciência e a Tecnologia MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR

AJP2023 3RD INTERNATIONAL CONFERENCE ON ADVANCED JOINING PROCESSES 19-20 October 2023 - Braga, Portugal