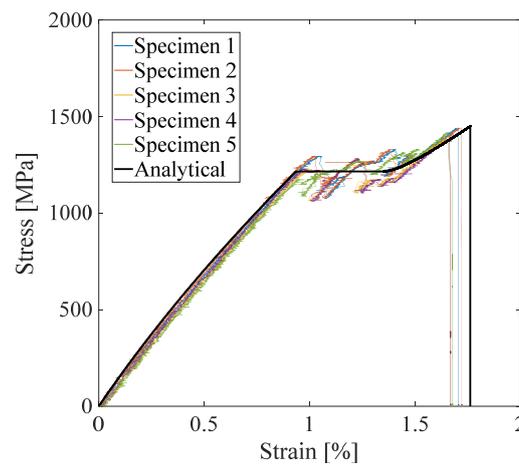


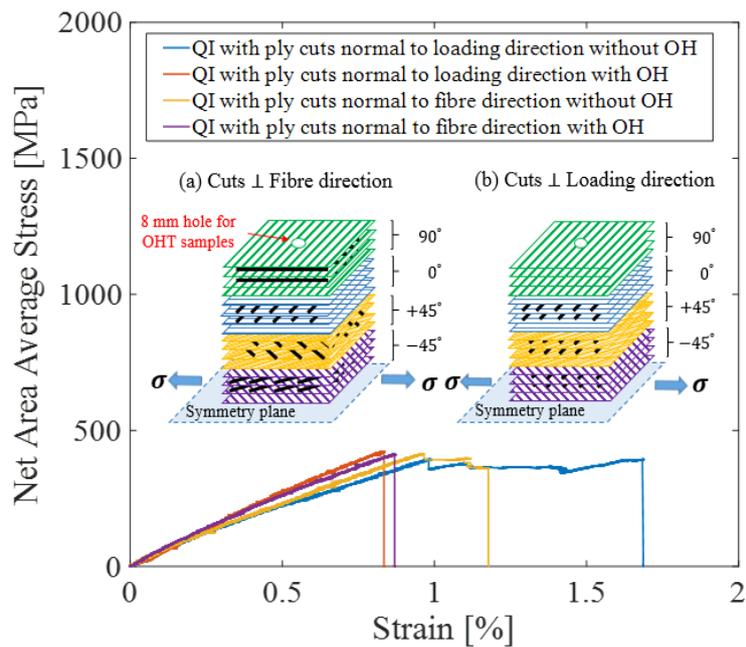
## HiPerDuCT Programme Grant

### Final report: Interlaminar and ply weakening

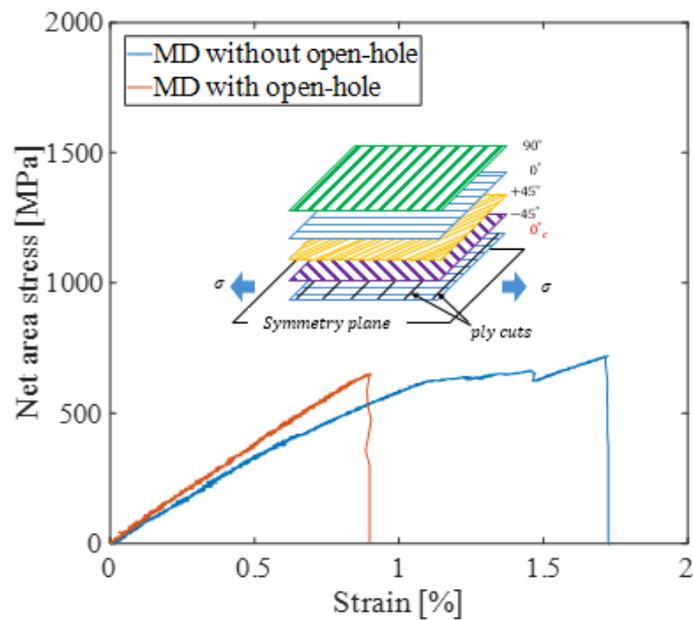
Controllable pseudo-ductile tensile behavior can be achieved by tailoring ply weakening in unidirectional (UD) CFRP laminate made of single carbon system (Hexcel® M21/35%/198/T800S prepreg). This has been investigated through FE modelling [1] and validated by experiments [2]. Delamination initiating from ply weakening (either cuts [2] or perforation) in the middle plies sandwiched between continuous plies of a unidirectional (UD) laminate promotes a plateau stage in the stress-strain curve (see Fig. 1). Pseudo-ductility was also achieved in quasi-isotropic (QI) [3] and 0-degree fibre dominated multidirectional (MD) laminates. A 4-ply UD cut-ply laminate (in which the middle two plies contained periodic ply cuts and the outer plies were pristine) was used as the 90-, 0-, +45- and -45-degree direction sub-laminates of the QI laminates (see Fig. 2). The MD laminates are made of two 0-degree plies containing ply cuts embedded in two blocks of QI ([90/0/+45/-45]) material (see Fig. 3). These QI and MD configurations are notch-insensitive, as shown in the open-hole tensile (OHT) behaviour (see Fig. 2 and Fig. 3).



**Figure 1.** Pseudo-ductile tensile performance of a UD 4-ply laminate containing 10 mm spaced ply cuts in the two middle plies



**Figure 2.** Schematics of two types of QI laminates containing 10 mm spaced ply cuts in the two middle plies of each sub-laminate and the corresponding tensile and open-hole tensile (OHT) behaviour



**Figure 3.** Schematic of 0-degree fibre dominated multi-directional (MD) laminates containing 10mm spaced ply cuts in the middle two 0-degree plies and corresponding tensile and open-hole tensile (OHT) responses

### References

- [1] Bacarreza O, Robinson P.: *Use of Intermittent Interfaces and Weakened Fibres to achieve Pseudo-ductility in Carbon-epoxy composites*. ICCM 20 Copenhagen, 19-24 June 2015.
- [2] J. Sun, O. Bacarreza and P. Robinson. Pseudo-ductility in UD CFRP through interlaminar and ply weakening. *ECCM 17, Munich*, 26-30 June 2016.
- [3] J. Sun, O. Bacarreza and P. Robinson. Pseudo-ductility in quasi-isotropic CFRP through ply weakening. *ICCM 21, Xi'an*, 20-25 August 2017.