Analysis of the coupling between the effects of transverse tension and shear on the matrix damage's evolution in a UD ply of an unbalanced hybrid woven Carbon/Glass-PEEK composite

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Failure of laminated composite structures is due to various mechanisms operating at different scales. Models based on Continuum Damage Mechanics can describe progressive and diffuse damage induced by small cracks along the fibres resulting with a stiffness loss but usually not leading to the laminate failure. However, the ply failure in the fibre direction is generally catastrophic for the laminate. Based on the strength decrease in the fibre direction for high transverse matrix damage levels, a model defined at the ply scale was proposed to describe the failure in the fibre direction for static and fatigue loads. [1,2,3,4]

An UD ply intra-laminar damage is the result of in-plane shear and transverse tension, but the damage due to the latter is difficult to study owing to its brittle behaviour. However, this premature failure [3] is not representative of its transverse behaviour in a laminate. In [4], transverse tensile tests on an unbalanced woven glass/epoxy 83/17 show no brittle failure as the weft fibres limit the cracks propagation to the whole specimen. So, a new unbalanced hybrid woven Carbon/Glass-PEEK composite 87/13 [5] has been especially developed for this study.

This work deals with the identification of the model parameters of the damage evolution law based on the observation of the stiffness loss during quasi-static tensile tests with loading/unloading cycles. As previously done [2,3,4], the first attempt in [5] was done using the assumption that the coupling coefficient c between the effects of transverse tension and shear on the matrix damage's evolution was equal to 1. Here, by analysing the $[+30°]_{12}$ laminate static test results with some added assumptions to simplify the calculations, c is found to be equal to 0.7. This is a value to be confirmed by other tests analysis and used in a new whole identification procedure to be done.

Hence, the transverse to the carbon fibres tension load, this study leads to a better identification of the model parameters for the matrix transverse damage.

References

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