TOWARDS A NORMATIVE PROTOCOL FOR DYNAMIC SHEAR TESTS ON [±45°] CMO SPECIMENS: GEOMETRY VALIDATION

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Carbon Fiber Reinforced Polymers (CFRP) are now widely use in aeronautics due to their interesting mass/rigidity ratio, which is better than usual metallic materials. CFRP materials present strain-rate dependencies especially for their shear behavior [1]. During intermediate strain-rate tests, users have the obligation to deal with wave propagation and different difficulties associated to the effort transmission or effort measurement. This is why laboratories generally propose a smaller sample geometry [2] than those used for standard tests at quasi-static strain-rates [3]. As there is no normalized definition of the geometry for the dynamic tests, it is likely to obtain different results between several laboratories. The objective of this study is to propose an experimental protocol to determine the sample geometry of CFRP, especially designed fort dynamic tests with hydraulic machines and [±45°] tensile tests.
Previous work [1] shows that a specimen with a length-to-width ratio λ = 2, considering a 15 mm width and a 4 ply thickness, allows to guarantee the representativity of the tests results for shear modulus evaluation [3]. However, the geometry used in [1] do not allow to be representative of the nonlinear behavior of a standard geometry specimen. The objective of the work presented in this paper is to determine the influence of the main geometrical parameters of a [±45°] specimen on the nonlinear shear behaviour of a T700/M21 composite material. In this study, the nonlinear behavior is characterized by cyclic incremental tests. For each cycle, the shear modulus (G_{lt}) and the irreversible strain (ε_{lt}^{irr}) are quantified. A scalar damage variable (D_{macro}) is used to characterize the rigidity loss. The scalar damage variable is the normalized value of the current shear modulus (G_{lt}^{i}) divided by the initial one (G_{lt}^{0}) [7]. Four different values of λ (5.2, 2.4, 2.2 and 2) are compared with the proposed protocol. Regarding these specimens, the width and thickness are respectively 25 mm and 8 plies [3].
In this study, the geometry ratio λ = 2 develops a different non linear behavior with respect to the other specimens from $\varepsilon_{lt}^{irr} \geq$ 0,1%. Furthermore, performing the [±45°] tensile test with the smallest possible ratio λ = 2 [1] leads to a higher scattering compared to the other values of λ ratio. To conclude, this study shows that the smallest ratio λ = 2.2 guarantees the representativity of the nonlinear behavior when compared to standard ratio λ = 5.2.
This work is part of a work aiming at developing a dynamic interrupted tensile test device applied to CFRP sample at [±45°]. The main objective is to analyse the strain-rate dependencies of the nonlinear shear behaviour of CFRP materials. The validation of the sample geometry used for dynamic tests aimed at partially answer to the lack of normative protocol for the dynamic characterization of composite materials.

References

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