10th International Conference on Composite Science and Technology
ICCST/10
A. L. Araújo, J. R. Correia, C. M. Mota Soares, et al. (Editors)
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Abstract ID-205

HYBRIDIZATION OF COMPOSITE SYSTEMS

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Keywords: Hybridization, Composite Systems, Analytical models

Summary: Composite systems are more and more used in highly demanding applications where low weight and high mechanical performance, together with chemical resistance and fire/smoke behaviour, are required. However, despite their excellent specific mechanical properties, their rupture process is, generally speaking "catastrophic", i. e. they don't show visible damage prior to rupture. In other words, they don't exhibit plastic behaviour, the engineer's safety belt, as most of metals do. Besides modifying resins, one can use the hybridization concept where more than one matrix or fibre can be used. In this paper, we will analyze Fibre Hybrid Composite Systems, in order to be able to enhance a pseudo-ductile behaviour.
The following are the most common fibre hybrid composites:
-Interlayer or layer-by-layer
-Intralayer or yarn-by-yarn
-Intrayarn or fibre-by-fibre
It is generally accepted that the hybridization effect is due to:
-Residual stresses
-Change in developing and propagation of damage
-Dynamic stresses concentration
Moreover, it is also considered the fact that mechanical properties don't show a constant value, i. e., being a stochastic variable they contribute to the hybridization effect.
The paper will present a state of the art review on the effect of hybridization on mechanical properties of composite systems.
Different simple analytical models (strength of materials approach, Voigt and Reuss approaches), as well as a finite element simulation that considers the generation of volume representative elements with aleatoric distribution of fibres, Melro [1], were used to predict the mechanical properties of an hybrid carbon/glass fibre epoxy composite with 60% volume fibre. The simulations presented consider different proportions for the two types of fibres.
Finally, an experimental study to determine the effect of volume fraction of each type of fibre on mechanical properties of hybrid carbon/glass fibre epoxy composite is presented.

References:
[1] António Melro. Analytical and Numerical Modeling of Damage and Fracture of Advanced Composites, PhD thesis, FEUP, 2011