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PROPOSITION MODEL OF MICROMECHANICAL DAMAGE TO PREDICT REDUCTION IN STIFFNESS OF A FATIGUED A-SMC COMPOSITE

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ABSTRACT

Sheet Moulding Compounds (SMC) are high strength thermoset moulding materials reinforced with glass treated with thermos-compression. SMC composites combine fibreglass resins and polyester/ phenolic/ vinyl and unsaturated acrylic to produce a high strength moulding compound. These materials are usually formulated to meet the performance requirements of the moulding part. In addition, the vinyl ester resins used in the new advanced SMC systems (A-SMC) have many desirable features, including mechanical properties comparable to epoxy, excellent chemical resistance and tensile resistance, and cost competitiveness. In this paper, a proposed model is used to take into account the Young modulus evolutions of advanced SMC systems (A-SMC) composite under fatigue tests.

Keywords: fatigue life prediction, micro-mechanics, discontinuous reinforcement.

INTRODUCTION

Composite materials are becoming increasingly attractive due to their ease of manufacture, relatively low cost, low density and good mechanical properties relative to weight. In order to design composite structures, it is imperative to predict their behaviour, taking into account the phenomena of damage [1].

As damage and cracks in polymers and composites influence the performance of structures through the progression of various mechanisms, understanding the creation of these defects, their detection and prediction are of scientific and industrial importance and value [2].

The model used in this study is a so-called "multi-scale" model, establishing direct links between the phenomena observed at the microscopic scale (at the composite microstructure level) and the global (macroscopic) behaviour of the SMC [3]. In this way, the laws of behaviour (tractions curves) can be traced and the stiffness of the material determined by its condition, damaged or not, depending on the microstructural parameters introduced.

RESULTS AND CONCLUSIONS

The proposed model combines two types of approaches (Figure 1), phenomenological and micromechanical, to take advantage of each of them. The objective is to seek an optimal compromise between the industrial applicability of the predictive model used and the relevance of the description of the physical phenomena taken into account while requiring only a limited number of experimental data.

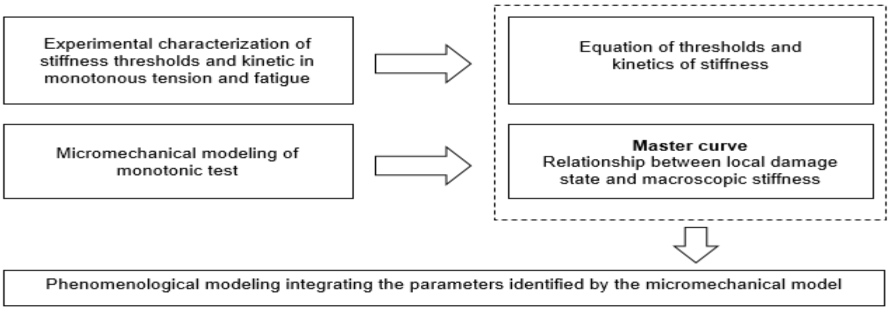
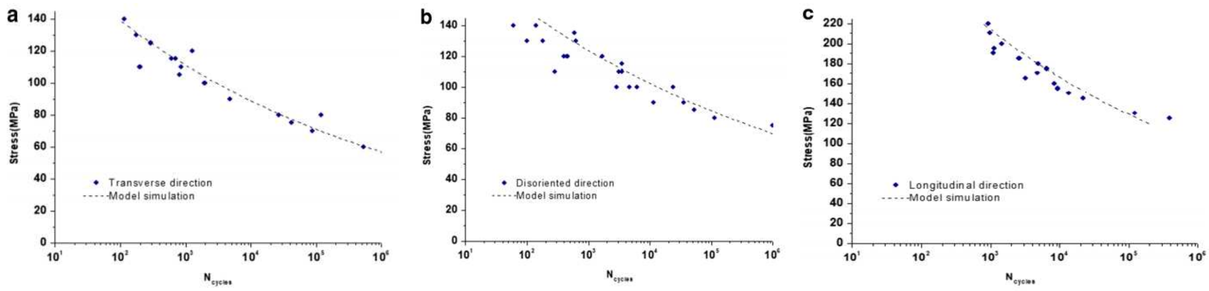


Fig. 1 - Representation of the proposed methodology

The comparison between the model and the experimental data is shown in Figure 2.



(a) (b) (c)

Fig. 2 - Comparison between experimental and model: (a) Transverse direction; (b) Disoriented; (c) Longitudinal direction [4]

For A-SMC material studied here, the dominant damage mechanism is interfacial decohesion, which leads to degradation of the mechanical properties, reduction in stiffness. This model is based on a quadratic interfacial criterion expressed in terms of normal and shear local stresses at the fiber-matrix interface. The proposed model and the used approach in good agreement with the experimental results.

REFERENCES

[1] Jendli Z, Meraghni F, Fitoussi J, Baptiste D, Multi-scales modelling of dynamic behaviour for discontinuous fibre SMC composites; Comp. Sci Technol 2009;69, pp.97-103.

[2] Shirinbayan M, Fitoussi J, Abbasnezhad N, Meraghni F, Surowiec B, Tcharkhtchi A, Mechanical characterization of a Low Density Sheet Molding Compound (LD-SMC): Multi-scale damage analysis and strain rate effect; Compos Part B 2017;131, pp.8-20.

[3] Fitoussi J, Guo G, Baptiste D, Determination of a tridimentional failure criterion at the fiber-matrix interface of an organic matrix/discontinuous reinforcement composite.

[4] Ayari H, Fitoussi J, Imaddahen A, Tamboura S, Shirinbayan M, Dali H Ben, Tcharkhtchi A, Two hybrid approaches to fatigue modeling of Advanced-Sheet Molding Compounds (A-SMC) Composite ; Applied Composite Materials, 2019.