Development of a methodology to predict fatigue lifetime of adhesively bonded structures: application to Renewable Energy Marine Structures

D. Thévenet, P. Bidaud, R. Créac'hadec, N. Carrere

Institut de Recherche Dupuy De Lôme, CNRS FRE3744
ENSTA Bretagne, 2 rue François Verny, 29200 Brest, France

Estimating capacities of adhesives to endure repetitive loadings is an essential point to perform fatigue assessments. Nevertheless, few studies have been performed on the cyclic behavior of adhesively bonded structures. In the methodology proposed to evaluate fatigue lifetimes of adhesively bonded structures, the two key objectives are: the characterization of the structural adhesive joints mechanical behavior and the definition of a relevant initiation criterion.

As a first step, the aim of this study is to describe the phenomena occurring in the bonded joint until the appearance of a macroscopic crack. The numerical work performed here relies on the identification of a viscoelastic-viscoplastic behavior law based on modified Arcan creep-recovery tests [1]. The definition of such a law behavior has shown interesting abilities to describe the mechanical behavior of bonded samples tested under cyclic loading. In a second step, the definition of a process-zone to apply the failure criterion is performed using a coupled criterion [2] able to locate the fatigue crack initiation.

This work is applied to the fatigue behavior of bonded structures for renewable energy marine applications. From this strategy, a fatigue life estimation of composite assemblies is proposed. Predictions of fatigue lifetime until 10^5 cycles are performed on technological samples with stress concentration areas under 4-point bending/torsion loading: typical case study of a wind blade assembly.

[1] AP. Bidaud, R. Creac'hcadec, D. Thévenet, J.Y. Cognard, P. Jousset, A prediction method of the behavior of adhesively bonded structures under cyclic shear loading based on a characterization of the viscous aspects of the adhesive in an assembly, *The Journal of Adhesion*, 91(9), 701-724, 2015.

[2] D. Leguillon, Strength or toughness? A criterion for crack onset at a notch, *European Journal of Mechanics – A/Solids*, 61-72, 2002.