Fatigue simulation of a fibreglass ship

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ABSTRACT

The use of composite materials to build marine structures is a fact. Prove of it is the construction of offshore turbines, military vessels, composite risers, etc. However, the characterization of such structures under fatigue loads is not well understood, what implies a larger scantling and safety ratios of the structures. Hence, it is necessary to develop numerical tools in order to predict this failure mode. The purpose of this work is to propose a numerical model for the analysis of the fatigue behaviour of marine structures made of composite laminates, which can be used to understand their behaviour in order to optimize them.

The formulation proposed to simulate the fatigue phenomena is based on the Serial/Parallel Rule of Mixtures (S/P RoM) [1] and a fatigue damage model [2] previously developed for metals. The SP-RoM can be understood as a constitutive law manager that provides the elastic and non-linear response of the composite from the constitutive performance of its constituent materials. The fatigue damage model is based on the definition of a reduction function which takes into account the cyclic degradation of the materials, acting on strength and stiffness; this function accounts for the number of cycles, maximum stress and stress amplitude. These two formulations are coupled applying the fatigue damage model to both composite components, fibre and matrix.

Current work uses the numerical procedure developed to characterize fatigue in composites. The model is calibrated based on the assumption that the failure mechanism of longitudinal loaded UD laminates is fibre-driven, while the failure mechanism of transverse loaded UD laminates is matrix-driven [3]. The composite resulting from this calibration is used, afterwards, to predict the fatigue performance laminated composites with different stacking sequences. The structure chosen for this analysis is a sub-structure of a fibreglass vessel.

This work is in the scope of FibreShip Project H2020 [4].

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