LAYER-BASED FATIGUE DAMAGE MODELLING AND EXPERIMENTAL VALIDATION FOR CARBON FIBRE REINFORCED PLASTICS UNDER DIFFERENT STRESS RATIOS

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Due to their excellent mechanical material properties, carbon fibre reinforced plastics (CFRPs) are used in complex structural applications, for instance in the automotive and aerospace industry. In order to guarantee a safe usage it is mandatory to have a detailed knowledge concerning the material damage behaviour. Compared to homogeneous isotropic materials, CFRPs show much more complex failure mechanisms because of their inhomogeneity and anisotropy. A current challenge is the accurate and computationally efficient prediction of the damage behaviour of CFRP during fatigue loading conditions.

Previously a huge effort has been made to develop different models for the lifetime prediction. In contrast to the high level of development in the static strength prediction, there is still no generally valid model for predicting the strength degradation under cyclic loading [1]. A recently developed fatigue damage model [2] overcomes different shortcomings of the existing models. This fatigue damage model (denoted as FDM) is physically based and is able to account for stress redistributions and sequence effects under fatigue loading.

In this contribution, the FDM is calibrated for CFRP and is used for the numerical simulation of the damage behaviour under quasi-static and cyclic loading for different stress ratios. The layer-wise degradation of the stiffness and strength properties, depending on the failure mode as well as the fatigue strain evolution, is predicted with increasing number of load cycles. The numerical findings are compared with experimental investigations [3] on the lamina and laminate level. Especially the influence of the mean stress on the fatigue damage behaviour is discussed in detail.

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