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FATIGUE EVALUATION AND ENHANCED SHEAR STRAIN MEASUREMENTS OF BONDED COMPOSITE JOINTS

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Summary: Bonded composite joints have many advantages in comparison to the implementation of conventional fasteners. However, adhesive bonding of primary aircraft structures is still a certification issue. Up to now, the potential existence of local weak bonds due to flaws or deviations during the manufacturing process must be taken into account. Stress concentrations at disbond edges may lead to growing cracks. One promising way to achieve airworthiness of bonded CFRP joints is the establishment of disbond-constraining design features. To evaluate such features, the crack growing behavior and the stress distribution within the bondline under typical loading conditions is studied and thus a thorough understanding of the fatigue performance is achieved.

In this study, a novel approach of shear strain measurement within the bondline of a bonded composite joint is presented. The usage of a high-resolution stereo digital image correlation system (DIC) allows a detailed investigation of the shear strain distribution within the bondline. The measurements are executed edgewise. Due to the high-resolution, detailed examinations even for a rather small bondline thickness (about 0.1 mm) of a typical aeronautical epoxy film adhesive system (Hysol EA9695) are possible. For this purpose, bonded CFRP crack lap shear specimens (CLS) are manufactured and tested under static tension loading conditions. In addition, the overall joint strength and the fracture pattern are evaluated for different artificial disbonds. The fracture pattern is investigated by use of a microscope.

Subsequently, the experimental investigations are extended to fatigue at several load levels. The crack growth and the crack growth rate are examined by use of two microscopes (one for each side). A predominant linear crack growth behavior is examined for all load cases. Thus, the CLS test is applicable for examinations of crack-constraining design features in subsequent studies. However, a non-linear relationship between global specimen strain and crack growth rate is observed indicating a significant higher crack growth rate for higher loads. Besides, crack growth was observed even for a comparatively small global strain. Thus, the results endorse the research of crack-constraining design features to establish adhesive bonding for primary aircraft structures that is done within the European project BOPACS.

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