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Failure analysis of adhesive bonds with polymorphic uncertainties: Experiment and simulation

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One of the typical failure mechanisms of rotor blades in operation are fatigue cracks in adhesive bonds that are in the focus of our project. Since the full-scale tests of rotor blades are very expensive, a representative sub-component, called the Henkel beam, has been developed by Fraunhofer IWES [1] and used to test various bond configurations.

The adhesive bonds in the Henkel beam are stressed mainly by uniaxial tension. Depending on the manufacturing process, the failure is often caused by air voids that can be characterized by their amount, size and distribution [2]. These properties could be generally quantified by non-destructive testing (NDT) like ultrasound and tomographic scanning that are subject of several polymorphic uncertainties. By using the NDT data, we simulate structural failure by means of a fuzzy-stochastic finite-element approach. In the present study, we compare numerical simulations with real experiments on representative specimens to validate the uncertainty models.

A MATLAB® framework called PolyUQ has been developed inhouse for solving polymorphic problems, also with an integrated interface to black-box finite-element solvers. The current state of this ongoing work will be presented and discussed at the conference.

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