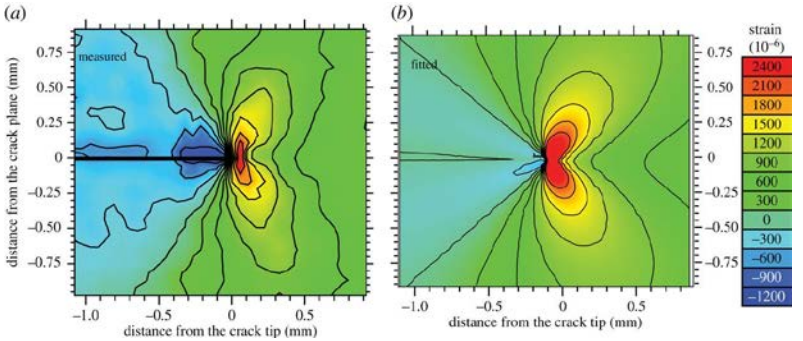
Bachelor‘s / Master‘s / Diploma Thesis, ET/MT/MB

Optical damage state determination for high-speed lightweight rotors

Motivation

The development of highly efficient turbomachines is crucial for the reduction of CO_2 emission in air traffic. Due to their high specific stiffness and tensile strength, fiber reinforced polymers (FRP) are predestined for the construction of efficient large diameter high-speed fan blades. However, their complex mechanical behavior impedes failure prediction. To investigate the correlation between damage state and structure dynamic behavior, FRP discs are accelerated to rotational speeds above 200 Hz inside a test rig. The deformation and vibration measurement is performed by the application and optical read out of diffraction gratings onto the rotor. An indicator of the damage state is the formation of cracks on the rotor surface.
The goal is to determine the suitability of the diffraction grating method to detect the surface cracks by sensing changes in their surrounding strain field. The method can potentially be used for simultaneous damage and vibration measurement of the rotor.

Rolls Royce UltraFan engine [RR19]



Exemplary influence of cracks on strain field [PW15]

Tasks

- Adaptation of a static loading and measurement setup
- Strain field measurement with the diffraction grating method and image correlation
- Comparison of the results and determination of the uncertainty budget

Key words

Optical strain measurement, experiments, MATLAB

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[RR18] rolls-royce.com/media/press-releases/2019/25-02-2019-rr-ultrafan-one-step-closer-as-advanced-low-pressure-system-alps-testing-gets-underway.aspx (05.03.2019)

[PW15] Fracture mechanics by three-dimensional crack-tip synchrotron X-ray microscopy,P. J. Withers, 2015