Programming of a simple cylinder model for the parameter identification of cohesive zone models

Background:

The importance of structural components made of fibre reinforced plastics (FRP) is continuously increasing in several engineering disciplines like aircraft or automotive. Especially their excellent mechanical properties (e.g. high strengths at low densities) offer many advantages over metallic materials.

For the design of structures made of FRP it´s necessary to have a detailed knowledge about the fatigue damage mechanisms leading to failure. One critical kind of damage is delamination often occurring due to the weak interlaminar strength of FRP.

Cohesive zone models (CZM) can be a suitable method for the numerical investigation of delamination with the finite element (FE) method. By means of CZM the crack initiation and propagation can be analysed within a predefined cohesive zone. This requires material parameters, which need to be identified by fitting simulation results to experimental results. This iterative process requires a high number of FE simulations leading to high costs.

The simple cylinder model (fig. 1) developed by Lopez Armas [1] provides the opportunity to identify such material parameter for CZM under pure mode I crack opening (Fig. 2) in a shorter time, because it doesn´t require expensive FE simulations. It´s therefore especially suitable for CZM describing delamination behaviour under cyclic loading. The cylinder model have already been used in a benchmark study conducted by Bak et al. [2] for the comparison of different cyclic CZM.

Objective

In this thesis, the material parameters for the new CZM of Joosten et al. [3] should be identified by means of the simple cylinder model. Therefore, a simulation tool has to programmed reproducing the kinematic of the cylinder model and the material behaviour of the CZM by Joosten et al. The parameter identification should be done by fitting simulation results to given experimental fatigue tests (cyclic DCB tests).

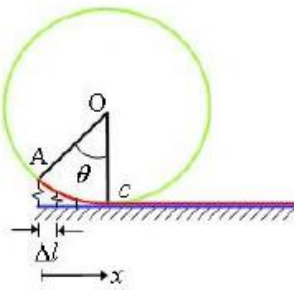

Fig.1: Cylinder model

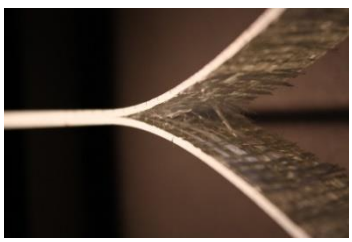

Fig.2: Mode I crack opening

Tasks:

1. Investigation of the theoretical background of cohesive zone modelling and the cylinder model
2. Programming of a simulation tool reproducing the kinematic of the cylinder model and the material behaviour of the cohesive zone model by Joosten et al.
3. Parameter identification for the cohesive zone model by fitting simulation results to given experimental results
4. Written and graphic representation as well as critical discussion of the results

Profile:

- Knowledge in at least one of the programming languages Fortran, Python or Matlab
- Knowledge in object oriented programming preferable

References:

[1] Lopez Armas CA. Evaluation of Constitutive Laws for the Computer Simulation of Fatigue-Driven Delamination in Composite Materials. Imperical College London Department of Aeronautics, 2008

[2] Bak B, Turon A, Lindgaard E, Lund E. A benchmark study of simulation methods for high-cycle-fatigue-driven delamination based on cohesive zone models. Composite Structures 164, 2017

[3] Joosten M, Davila C, Yang Q. Predicting fatigue damage in composites subjected to general loading conditions. Composites: Part A 156, 2022

Contact:

Gereon Hacker, M.Sc.
Institut für Statik und Dynamik
Appelstr. 9A
30167 Hannover
Email: g.hacker@isd.uni-hannover.de