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Phase-field modelling of fatigue fracture in aluminium sheets

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The design of aircraft fuselages depends greatly on the crack propagation rates of fatigue cracks within the component due to the cyclic expansion and contraction. Our aim is to model fatigue fracture in often for aircrafts used aluminium sheet material.

The phase-field method is a promising approach to model arbitrary fracture phenomenas. However, fatigue comes along with high numbers of load cycles, so an explicit simulation of the load path is very expensive. Therefore, time-efficient simulation methods are required. In this contribution, we approach this challenge by combining the phase-field method for brittle fracture with the local strain approach (LSA) [1], an empirical method originally designed for life span estimation of metallic components. In this way, we avoid the explicit simulation of the load cycles by executing a local cyclic damage accumulation. Based on that, the critical fracture energy is degraded locally in order to describe the dissipation due to damage.

After introducing this fatigue concept [2] und parametrising it for aluminium material [3], we now want to take the anisotropy due to the rolling process of the sheets into account. It leads both to a direction dependency of the crack resistance, expressed by the material parameter fracture toughness, and the resistance against fatigue damage which we want to come by with a critical plane approach.

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