# Specimen design and instrumentation for monitoring fatigue crack growth initiating at ply drops

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## Abstract

Unpredictable and excessive loads, for example caused by aerodynamic interaction between different turbines, can accelerate fatigue damage in wind turbine blades (Ghosal et. al (2000)). Fatigue damage can also initiate in the early service life of a wind turbine blade in regions of stress concentration, such as those caused by ply drops (Cairns et al. (1999)). Due to these issues, the design philosophy is based on conservative analysis methods and inspections at certain time intervals are required to assess the damage in the wind blades.

An alternative approach is to use damage tolerant materials and a structural health monitoring system (McGugan et al. (2015)). In this approach, a distribution of damage types within the blades is accepted as long as they can be detected by structural health monitoring techniques and their severity evaluated by material damage models.

The present work aims to demonstrate this design philosophy at the laboratory level. A test specimen, which includes ply drops at different distances from each other, is tested under static and fatigue loads. The aim is to investigate if cracks starting from these locations are

stable (damage tolerant) and if the cracks and their location can be detected by non-destructive methods (detection of damage initiation and evolution).

The focus of the paper is on the experimental details and set-up: a) Design of the specimen based on a finite element model. b) Manufacturing of the ply drop specimens including manufacturing issues when embedding fibre Bragg grating sensors. c) Instrumentation of the test specimen e.g. strain gauges, acoustic emission sensors, fibre Bragg grating sensors.

Selected static and cyclic results will be presented showing that certain damage types (cracks at ply drops) are stable and thus not critical for the integrity of a structure (wind turbine blade) and that structural health monitoring techniques (acoustic emission and fibre Bragg grating sensors) can detect damage initiation and monitor the damage evolution.

**References**

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