A NUMERICAL AND EXPERIMENTAL STUDY OF FACE/CORE INTERFACE FATIGUE CRACK GROWTH IN A SANDWICH BEAM

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Summary. The aim of this study is to simulate fatigue crack growth in the face/core interface of a sandwich tear test (STT) specimen. In order to simulate fatigue crack growth, a routine including a method to accelerate the simulation is implemented in the commercial finite element program, ANSYS. The proposed method (the cycle jump technique) is based on conducting finite element analysis for a set of cycles to establish a trend line, extrapolating the trend line spanning many cycles, and use the extrapolated state as initial state for additional finite element simulations. Fatigue tests were conducted on the STT specimens to validate the finite element model and cycle jump technique. The crack growth in fatigue tests was traced using digital image correlation (DIC).

ABSTRACT

A sandwich composite consists of two stiff thin face sheets separated by a lightweight core. The face sheets in the sandwich carry in-plane and bending loads and core resists shear loads. This configuration offers an optimized structural solution with high stiffness to weight ratio suitable for varieties of weight critical application like airplanes, wind turbine blades and ships. Face/core debonding due to manufacturing flaws or in-service damages is one of the most critical and common damages in sandwich structures, as the basic sandwich principle is compromised resulting in a lack of structural integrity and reliability. Once a debond is initiated in a sandwich structure depending on the face/core interface properties and loading, it may propagate and causes catastrophic damages in the structure. One of the most important loading scenarios which is crucial in debond propagation is cyclic loading. Design against debond fatigue failure in layered structures like monolithic and sandwich composites is associated with many challenges due to the complexity of the interface fracture problem. Typically to assess the damage tolerance of a layered structure exposed to fatigue loading, experiments are conducted on both intact specimens and on specimens with a pre-existing crack. In recent years few experimental studies on the face/core fatigue debond growth, have been reported in the literature [1-3]. Berkowits and Johnson conducted fatigue tests of a modified double cantilever beam (DCB) of honeycomb core and carbon/epoxy face sheets [1]. They used the compliance of the DCB specimen to determine the crack length and the crack
growth rate [1]. Shipsha and co-authors determined the crack growth rate in the interface of a cracked sandwich beam (CSB) under global mode I and II loading experimentally [2]. Shafiq and Quispitupa conducted fatigue tests of sandwich beams via three-point bending [3]. Due to the difficulties and expenses associated with conducting fatigue experiments, in recent years many studies have been conducted to simulate crack growth in layered structures using numerical methods [4-6]. However, in the mentioned studies due to the need for a high density mesh at the crack tip, the simulation is limited to few cycles. In this paper, by exploiting the cycle jump technique, this problem has been overcome and conducted fatigue tests on STT specimens are simulated and lifetime estimations compared. Figure 1 shows the test set up and fatigue crack growth path of the STT specimens tested.

![Test Set Up](image1)

![Fatigue Crack Growth Path](image2)

**Figure 1:** STT specimen test fixture and Fatigue crack growth path

**REFERENCES**


