Influence of Dynamic Loading on Fracture of Face sheet-to-Core Interface in Sandwich Fracture Specimens

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Key words: Sandwich fracture specimens, debonding, dynamic fracture, finite element analysis

Abstract. The performance of sandwich composites is primarily determined by the mechanical behaviour of the face sheet-to-core interface in them. Hence, problems related to the debonding should be investigated comprehensively to prevent the disintegration of sandwich structural systems or to control this potentially harmful phenomenon in them. The deterioration effects of debonding in sandwich composites are more complicated in the case of dynamic loading [1-3]. Thus, the influence of dynamic loading on strength and fracture of the face sheet-to-core interface in sandwich composites is examined in this study by using double cantilever beam (DCB) specimens.

Debonding fracture analyses considered herein are based on the interfacial fracture theory including crack-like singularities between two dissimilar anisotropic layers within the framework of LEFM. First, the fracture toughness problem of a sandwich material in terms of a complex stress intensity factor for a sandwich DCB specimen subjected to static loading has been considered. Both the J-integral approach based on the classical beam theory and the numerical solutions resulting from finite element calculations with the ABAQUS package using 2-D and 3-D models [4] for the tri-material sandwich DCB specimen with debonding have been exploited. After that, dynamically loaded sandwich DCB specimens with a stationary interfacial crack have been modelled with ABAQUS solving 2-D and 3-D elasto-dynamic problems which involve the inertial effects to compute dynamic stress intensity factors. A fast impulse load and long-term dynamic harmonic loading have been considered for those specimens, with tension and/or moment loads being applied.

Numerical evaluations are carried out to quantify the effect of geometry, material parameters and dynamic loads on the local mode mixity at the crack tip and the magnitude of the stress intensity factors for the interfacial crack in the sandwich material. It has been demonstrated that the variation of geometrical and elastic mismatch between the face sheets and the core affects the mode-mixity conditions in the sandwich DCB specimens. From the dynamic analyses it appears that the strong dynamic effect observed in the DCB specimens concerning the variation of dynamic stress intensity factors with time and its dependence on the type of load applied can be mainly explained due to stress wave interaction between waves reflected from the crack front and ones excited by external loads.

References

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