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Finite element modelling and simulations of sandwich beam dynamics considering crack growth and contact

Vyacheslav Burlayenko

Abstract: Dynamic crack propagation in double cantilever beam (DCB) sandwich specimens is analysed numerically using the finite element method implemented into the ABAQUS code for a planar beam model with an initial interface skin/core crack subject to dynamic loading at the specimen's legs. The interface crack is constrained to grow along a weak skin/core interface directly ahead of the initial crack tip. A cohesive constitutive relation, which relates tractions and displacement jumps, is specified across the weak interface. The material on the constitutive layers of the specimen is assumed to be linear elastic. The contact effects between the DCB legs are also accounted for modelling, and corresponding numerical methods are discussed. Simulations are carried out using the plane strain elements available in ABAQUS to examine the statics and dynamics of the DCB modelling its configuration in the actual experiments. The dynamic strain energy rate at given crack speed or the crack history for a given fracture toughness is calculated. The stress wave effects on the dynamic strain energy release rate and the evolution of near crack tip stress fields are discussed. The finite element results are compared with the beam solutions and some experimental data available in the literature. The effects of various load conditions are also explored. It is found that a high loading rate results in developing on the interface in the crack tip vicinity shear stress waves and that the crack growth can take place at a load lower than a value determined by quasi-static or low rate values.

[1] Vyacheslav Burlayenko, Associate Professor: National Technical University "Kharkiv Polytechnic Institute", 61002, Ukraine (UA), burlayenko@yahoo.com .