Evaluation of facesheet-to-core interface strength in sandwich panels in the dynamic debonding propagation analysis

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Sandwich panels are widely used as structural components in applications for which materials with high stiffness and strength at a low specific mass are required. However, load carrying capacity of sandwich composites is highly sensitive to manufacturing defects or in-service damage. The most common of them is the facesheet-to-core debonding that may easily occur because of low toughness of the composite bi-material interface [1].

Generally, the interfacial strength of the sandwich structure is evaluated by the standard tests and it is discussed in terms of the ERRs or singular stresses at the interfacial crack front in the fracture sandwich specimens subjected to static loading. However, the debonding progression is strongly affected by the time rate of the external loading, which typically produces high amplifications of the fracture parameters [2]. This work is focused on dynamic debonding phenomena. First, the evaluation of dynamic intensity of the singular stresses near the tip of interfacial crack using a combination of analytical and numerical techniques for two-dimensional sandwich panel models is performed. From this fracture analysis, appropriate material fracture parameters are extracted and the dynamic stress behaviour at the bi-material interface is examined. Further, this information is used to create a three-dimensional model of the sandwich panel with an embedded debonded region using the capacities available in ABAQUS code.

The debonding propagation analysis in 3-D sandwich panels subjected to dynamic loading is carried out using the cohesive zone model implemented into cohesive elements of ABAQUS [3]. These elements are placed between the volumetric finite elements of the facesheets and the core. The most important fracture modelling features depending on the variation of the cohesive model parameters are considered and the predicted results are compared with those known in the literature. Then, various types of dynamic loads are applied to the debonded sandwich panels and their influence on the debonding behaviour of the sandwich composites is discussed in detail. Herewith, the dependence of the interfacial fracture phenomenon on the loading rate and the velocity of debonding growth is taken into account by programming appropriate visco-elastic constitutive models via the capacity of user-defined material subroutines of the ABAQUS code.

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