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Simulation until failure of a stiffened panel with progressive damage and delamination

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ABSTRACT

Virtual testing of laminated composite structures requires a meaningful simulation of non-linear behavior of both interlaminar and intraply mechanical properties up to complete failure. In stiffened panels under axial or bending loads, where delamination at the panel-stiffener plane is likely to appear as well as fibre failure and matrix cracking, this requirement is of clear importance.

Sub-ply three-dimensional damage models able to represent both interlaminar and intralaminar failure mechanisms are computationally unaffordable for real-size structures and feasible approaches deal with both questions separately. Damage mechanics models have been specifically developed for composites in previous works [1]. Delamination, on the other hand, has been accounted for by means of cohesive elements. The main characteristics of these elements are the accurate kinematic representation of the fracture process, based on a strong discontinuity in the displacement field, and the constitutive models which determines damage onset and propagation under variable mode ratio [2].

The cohesive zone models developed for quasi-static loading conditions have been recently enhanced to predict the propagation of delamination under fatigue loading [3]. The energy dissipated during fatigue crack growth is related to experimentally obtained da/dN curves, thus establishing a link between Fracture Mechanics and Damage Mechanics.

The finite element simulation of an stiffened panel should solve some difficulties related to the complexity of the geometry or to the large size of the structure in relation to the characteristic lengths of the damage mechanisms. For instance, the use of cohesive elements requires the inclusion of several elements in the cohesive zone. The authors have previously developed a methodology that enables the use of coarse meshes ahead of a crack tip [4]. This methodology and the fatigue model [3] requires an accurate estimation of the cohesive length in finite-sized orthotropic components. In this contribution a model to estimate accurately the length of the cohesive model is used to simulate delamination over an stiffened panel.

REFERENCES

[1] P. Maimí, P.P. Camanho, J.A. Mayugo and C.G. Dvila A continuum damage model for composite laminates: Part I Constitutive model *Mechanics of Materials*, **39**, 897-908, 2007.

[2] A. Turon, P.P. Camanho, J. Costa, C.G. Dávila, A damage model for the simulation of delamination in advanced composites under variable-mode loading, *Mechanics of Materials*, **38**, 1079-1089, 2006.

[3] A. Turon, P.P. Camanho, J. Costa, C.G. Dávila, Simulation of delamination in composites under high-cycle fatigue, *Composites Part A*, **38**(11), 2270-2282, 2007.

[4] A. Turon, C.G. Dávila, P.P. Camanho, J. Costa, An engineering solution for solving mesh size effects in the simulation of delamination with cohesive zone models, *Engineering Fracture Mechanics*, **74**(10), 1665-1682, 2007.