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# A NONLINEAR DOMAIN DECOMPOSITION METHOD FOR THE SIMULATION OF DELAMINATION, BUCKLING AND CONTACT IN LAMINATED COMPOSITES: SOME IMPROVEMENTS AND EXAMPLES

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One of the current challenges in the prediction of the nonlinear response of composites is to confront difficulties as i) complex states of stress ii) instabilities and iii) the huge size of the problem to solve. In this way, the high refinement of the required Finite Element discretisations, even when using calculations on the mesoscale, leads to considering the applicability of parallel and multiscale computations. These are mature techniques in the linear case, but much remains to be done in the nonlinear field.

The authors proposed a LATIN multiscale domain decomposition strategy to simulate the interactions between multiple through-the-width delaminations and buckling in composite laminates, taking into account possible contact between the delaminated surfaces [1, 2]. The geometrically nonlinear evolution is handled through a total Lagrangian formulation and delamination is modeled on the mesoscale using a cohesive interface model based on damage mechanics [3]. Unilateral contact conditions are introduced by means of an interface law. To solve the problem, three scales are considered: i) the micro-scale associated with a fine discretization of each substructure, ii) the macro-scale ensuring the propagation of the high-wavelength part of the solution and iii) the supermacro-scale solving the macro-scale problem when a huge number of plies is used.

In order to reconnect the micro and macro scales of the strategy, the iterative technique introduces parameters which are associated to the influence of neighboring subdomains. These parameters have been adapted i) to the aspect ratios of the slender structures, ii) to the state of damage on the cohesive interfaces and iii) to the interface's state (contact or not) in order to obtain a compromise between convergence rate and computing time.

A preliminary example is shown in Fig. 1. It is a $[0°/90°]_s$ composite plate, submitted to compression and pre-delaminated on the central interface and on the upper one. A normal force is applied on the top layer to induce buckling. The problem is split into 1,280 substructures leading to 3,248 interfaces, 2 millions of d.o.f. are involved. The macro-problem has 30,000 d.o.f. when the super-macro one only involves 168 d.o.f. The time interval is discretized into 120 times steps and 30 processors have been used. On Fig. 1, the load-normal displacement responses for the three groups of layers in the middle of the plate are plotted and it is shown the three typical configurations during the test.

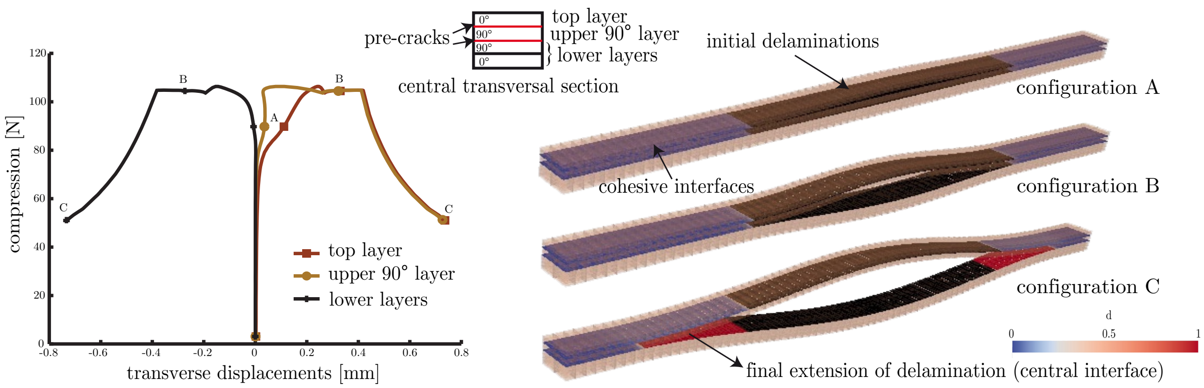


Figure 1: The load-displacement curve and its three typical configurations. (A: all plies separated, B: recontact, C: ruin)

For the time being, the enhancements on the strategy and some improvements on the code are making possible the treatment of more complex problems. More precisely, un example of compression of a laminate after impact will be presented during the conference.

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