Low intrusive coupling of implicit and explicit integration schemes for structural dynamics: application to low energy impacts on composite structures.

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ABSTRACT

Simulation of low energy impacts on composite structures is a key feature in aeronautics. Unfortunately they are very expensive: on the one side, the structures of interest have large dimensions and need fine meshes (at least locally) in order to capture damages (intralaminar progressive damage model [1], cohesive zone elements, ...); on the other side small time steps are required to ensure the explicit algorithms stability which are commonly used in these kind of simulations [2]. Implicit algorithms are in fact rarely used in this situation because of the roughness of the solutions that leads to prohibitive expensive time steps or even to non convergence of Newton-like iterative processes.

It is also observed that rough phenomenons are localized in space and time (near the impact zone). It may therefore be advantageous to adopt a space/time multiscale approach by splitting the structure into several substructures owning there own space/time discretization and their own integration schemes. The purpose of this decomposition is to take advantage of the specificities of both algorithms families: explicit scheme focuses on rough areas while smoother (actually linear) parts of the solutions are computed with larger time steps with an implicit scheme.

We propose here an implementation of the GC method [3] by the mean of low intrusive coupling between the implicit code *Z-set* and the explicit code *Europlexus*. The GC method is based on dual domain decomposition methods that include specific kinematic quantities interpolations in the time direction ensuring proper stability properties. The interface operators are directly constructed by assembling Schur complements on each subdomain. On explicit domains, these operators easily come from the diagonalized mass matrix and are indeed kept constant during the simulation whatever the non-linearities evolution.

Simulations of low energy impacts on composite stiffened panels are presented. It is shown on this application that time step ratios up to 1000 can be reached without degrading the solution compared to a monoscale reference one. Operations related to the interface resolution still remain a bottleneck in terms of cpu time especially if domains interfaces need to be updated. This opens new ways of improvements which are developed.

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