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A WEAKLY-INTRUSIVE COUPLING SCHEME IN SPACE AND TIME FOR LOCALIZED EFFECTS IN EXPLICIT DYNAMICS

O. Bettinotti[*,1,2,3], **O. Allix**[1], **B. Malherbe**[2] **and V. Oancea**[3]

[1] LMT-Cachan, 61 avenue du Président Wilson, Cachan, France, {bettinotti,allix}@lmt.ens-cachan.fr
[2] Airbus Operations, 316 route de Bayonne, Toulouse, France, benoit.malherbe@airbus.com
[3] DS Simulia, 166 Valley Street, Providence RI, United States, victor.oancea@3ds.com

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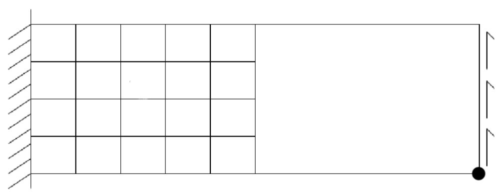
Composite laminated materials are increasingly employed in aeronautics but can be prone to extensive delamination when submitted to impact loads. So, the necessity to perform virtual delamination testing under impact, i.e. to be able to predict the extension of damage in the structure, becomes essential to engineering workflows. In that case, the use of a fine modeling scheme for laminates seems desirable. However, the computational cost associated with such modeling scheme would be prohibitively high for large structures in the engineering practice, as the precise study of the damage and failure response requires the consideration of phenomena encompassing multiple scales both in space and time.

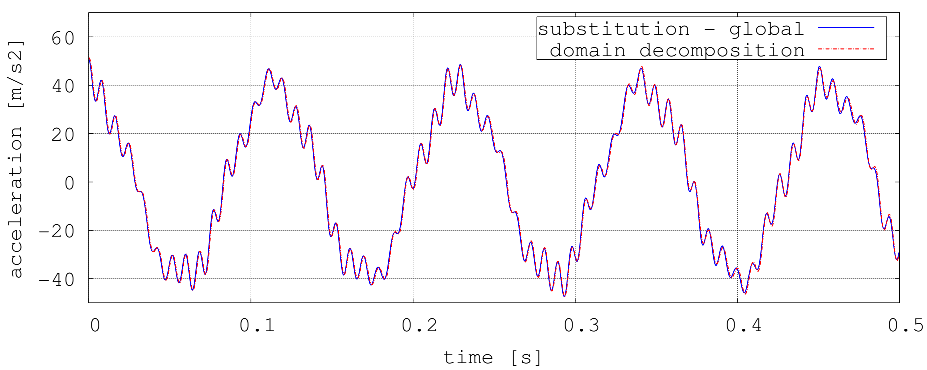
The main purpose of the present work consists in reducing the computational costs using a refined model only in a limited zone and a coarse model to the rest of the domain. To date, many methodologies are available for coupling different models, e.g. the non-overlapping Domain Decomposition method introduced in [1] and studied in following papers for coupling incompatible meshes, time steps and time integration schemes. Nevertheless, for treating evolutive analyses, such methodology needs to be combined with a re-meshing algorithm. The mesh generation in the pre-processing part of a FE-based commercial software represents a significant package that requires robustness. For this reason, a re-meshing algorithm in the course of the dynamic computation is considered as intrusive implementation.

Today, the intrusivity is becoming an important feature for creating operational design tools and has been studied for coupled analysis in many industrial research activities such as shell-to-solid coupling, stochastic coupled problems and static problems with local nonlinearities [2].

In this work, the basis of a proposed weakly-intrusive approach, called Substitution method [3], will be presented. The method is inspired to the global-local approaches and is designed in such a way that it is possible to make use of the unchanged coarse model applied to the whole structure and to couple it with the refined model only where required. In this way, an adaptive strategy can be driven by the activation or deactivation of local patches completely overlapped to the global domain. The computational price to pay is that the method is "locally" iterative. The verification of the Substitution method in comparison with the Domain Decomposition method (see Figure 1) and some potential advancements for improving the efficiency of the iterative process will be discussed. Then, the application to a commercial software package (such as Abaqus/Explicit) will be shown with a first development prototype without adaptivity. Estimates of potential advantages of multi-scale strategies compared to monolithic solutions for industrial applications will be also given.



(a) *monitored point*



(b) *vertical accelerations*

Figure 1: Comparison between Substitution and Domain Decomposition

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