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POST-BUCKLING ANALYSIS OF LARGE STRUCTURES: PRIMAL AND MIXED NON LINEAR DOMAIN DECOMPOSITION METHODS.

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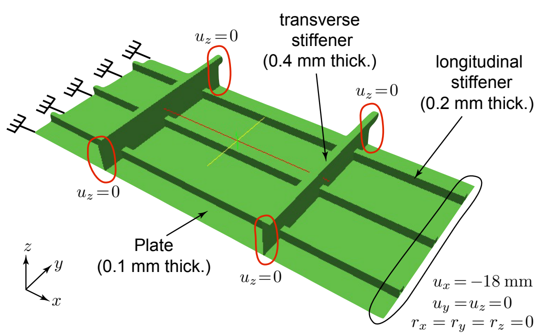
Performing nonlinear analysis of large structures at fine scale is one of the industrial challenges of our times. The post-buckling analysis of aeronautical structures is a typical example. During the structural tests for certification achieved on complete fuselages of aircraft, local buckling of the skin between stiffeners occurs, these nonlinear areas can expand and provoke redistributions of stresses in the structures. For workloads usually met in service, these phenomena are reversible, the material remains in the elastic domain. However, they can provoke stress concentrations at the bases of stiffeners and may be at the origin of local damages leading to global failure.

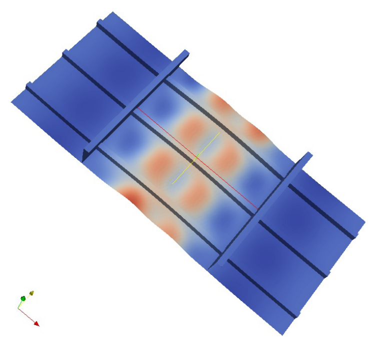
The direct analysis at the detailed scale of industrial structures is inaccessible at the moment due to computational costs and/or computational memory issues. In this context, the analyses at different scales (complete structure, structure details) are introduced in the computation. These multiscale methods are not new and they are generally used for independent linear analyses on different parts of the plane, in a kind of Domain Decomposition Methods (DDM) approach. In the case of nonlinear analysis, these multiscale approaches are often used in descendant approaches, from the global scale to the local one by engineers. A coarse and linear global computation is followed by fine nonlinear analysis on the zone of interest. However, these non-linear local analysis cannot take into account phenomena like stress redistribution or nonlinearities expansion, since they only offer a limited dialogue between scales.

In this study, we explore the possibilities related to DDM and parallel approaches in the context of geometrically nonlinear problems. In a first part, we investigate the efficiency of a new strategy [1] based on the Newton-Krylov-Schur (NKS) method [2].More precisely, this strategy includes a nonlinear localization step, which consist in performing additional iterations per substructure after each global computation at the interfaces in order to enforce the nonlinear behavior and equilibrium at the substructure level.This strategy follows one of the ideas developed in the LaTIn method [3], enabling to treat nonlinear phenomena at the scale where they are actually occurring, within substructures. Two DDM are implemented: a primal [4] and a mixed one [1]. A dual version is described in [5]. This strategy has been parallelized with a BDD-C method and to overcome nonlinearities a path following method has been introduced [6].

In this work these methods are illustrated and compared on a stiffened panel example, representative of a typical aeronautical structure (Figure 1). Also, the stiffened panel is decomposed in a different way in order to determine the influence of the decomposition.



(a) Boundary conditions



(b) Global and local buckling

Figure 1: Stiffened pannel, representative of an aeronautical structure.

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