A parallel approach for the numerical solving of plasticity problems: nonlinear condensation and substructuring with diverse interface conditions - COMPLAS 2017

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ABSTRACT

Numerical techniques for solving large nonlinear problems in parallel – such as the simulation of plastic behaviors in mechanical structures – often combine a Newton algorithm and a linear domain decomposition (DD) approach [1]. This process is not always optimal, especially in the case of localized high levels of nonlinearities (cumulated plasticity in weak parts of a structure for instance). Indeed, a better way for capitalizing the parallelization technique in this context would be to use a nonlinear version of the DD approach, where the interface problem is build from nonlinear local equilibriums, a priori more accurate than their tangent local counterpart.

Starting from this consideration, we propose here a new solving process, which decomposes the global nonlinear large-scale problem in several little nonlinear subproblems, corresponding to subdomains' equilibriums [2, 3]. These subproblems are solved independently, and connected by the interface continuity conditions: local Newton algorithms are used for substructures' equilibriums, and a global Newton algorithm is applied to the interface problem. A classical linear version of DD approach is then used to solve the resulting tangent system, through a Krylov solver. The interest of such algorithms is to improve the scalability of the DD method by reducing the number of communications between subdomains – and thus, processors. Indeed, when comparing the new approach with the classic one, we observe that the numbers of outer Newton and inner Krylov iterations are reduced at the price of few extra inner independent Newton loops.

Last but not least, the choice of interface transmission conditions – among primal, dual or mixed [4] – can strongly influence the performance of the method, in particular in the context of plasticity. A study of different test cases will illustrate this phenomenon, and some strategies of optimization of the interface conditions will be presented.

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