

A parallel strategy for the non linear computation of highly heterogeneous and flexible structures

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Multi-layer steel-elastomer structures are widespread today in industry for the realization of efficient elastic supports, thanks to remarkable mechanical properties. In particular, the orientation of the nozzle of a solid propellant booster is carried out by means of such a flexible structure. This one is made up of spherical reinforcements, out of steel or composite material, separated by very flexible rubber pads. It is in addition maintained by two metal supports.

The numerical simulation of these structures raises great difficulties, which are mainly due to the high heterogeneity, the nonlinear and quasi-incompressible behavior of elastomer, the large deformations, and their three-dimensional geometry. It leads to the solution to very large-scale ill-conditioned problems and appears often difficult indeed impossible with classical computers mainly because of limited memory sizes and excessive computing times. The use and the development of a parallel computational strategy then prove essential in order to achieve an efficient numerical simulation of this type of structure.

The non-linearities and the quasi-incompressibility are dealt with by the implementation of the classical Newton type method leading to the solution to a succession of linear systems of non invariant matrices and right hand sides. Each linear system is solved by a domain decomposition method (FETI) [1].

We will then describe the building of an efficient iterative solver, which, associated on the one hand with Krylov-type acceleration techniques (IRKS [3], GKC [2]) and on the other hand with a relevant initialization allows to significantly increase, not only convergence but also the robustness of the iterative solver. Lastly, to deal with the difficulties relating to the high heterogeneity, we will show how a judicious choice of auxiliary constraints anticipating the behavior of the steel-elastomer interfaces enables us to define a relevant coarse problem [4] also increasing the robustness of the FETI approach.

The performance of this parallel strategy will be illustrated with the example of the complex industrial flexible structure described here above.

References

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