Iterative solvers and reduced-order modelling for the simulation of lattice structures

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ABSTRACT

The development of technologies like additive manufacturing, combined with topology optimization techniques, has given rise to new lattice structure designs with a diversity of applications ranging from the aerospace to the chemical industry. These structures, however, are costly to solve via the Finite Element Method (FEM) since it involves the solution of large-scale systems, especially for 3D geometries. Direct solvers are incapable to handle large-scale systems due to its memory and time requirements, hence the use of (fast) iterative solvers becomes the only viable alternative.

With the aim of alleviating the computational cost of numerical simulations, Reduced Order Models (ROMs) were developed. These provide faster solutions but always at the expense of a (relative) loss of accuracy. In this study we combine a ROM called Empirical Interscale Finite Element Method (EIFEM) [1] within a conjugate gradient solver, this way we target the full FE solution while accelerating the iterative scheme. We show some numerical examples and compare the results with other preconditioners.

REFERENCES

[1] J.A. Hernández, A. Giuliodori, E. Soudah, Empirical Interscale Finite Element Method (EIFEM) for modeling heterogeneous structures via localized hyperreduction, Computer Methods in Applied Mechanics and Engineering, Volume 418, Part A, 2024, https://doi.org/10.1016/j.cma.2023.116492.