

## A first order hyperbolic framework for large strain computational solid dynamics: A vertex-centred Updated Lagrangian scheme

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### ABSTRACT

Current industrial codes (e.g. ANSYS, LS-DNA) for the simulation of large-scale solid dynamics problems are typically based on the use of traditional displacement-based finite element formulations. However, these formulations present a number of shortcomings, namely, (1) reduced order of convergence for strains and stresses, (2) poor performance in bending and shock dominated scenarios and (3) appearance of numerical instabilities associated with volumetric locking and non-physical pressure fluctuations.

To circumvent these drawbacks, a system of first order hyperbolic conservation laws for large strain solid dynamics was introduced in [1–3]. Essentially, the formulation was established in terms of the linear momentum and the deformation gradient tensor [3]. This paper builds on recent Total Lagrangian based work [1] developed by the authors, by introducing a vertex centred Finite Volume Method on a mixed Updated Lagrangian formalism, with the aim of further enhancing the robustness of the algorithm. In the case of extremely high nonlinear deformations, the Updated Lagrangian framework provides extra flexibility into the formulation, thus extending the range of applications to near incompressibility. For computational efficiency, an adapted artificial compressibility approach is also introduced for truly incompressible materials [2].

A series of numerical examples are presented in order to assess the robustness and the applicability of the proposed framework, benchmarking it against an ample spectrum of alternative numerical strategies developed by the authors in recent publications [1–3]. The overall scheme shows excellent behaviour in shock and bending dominated nearly incompressible scenarios without spurious pressure oscillations (see Figure 1), yielding second order of convergence for both velocities and stresses.

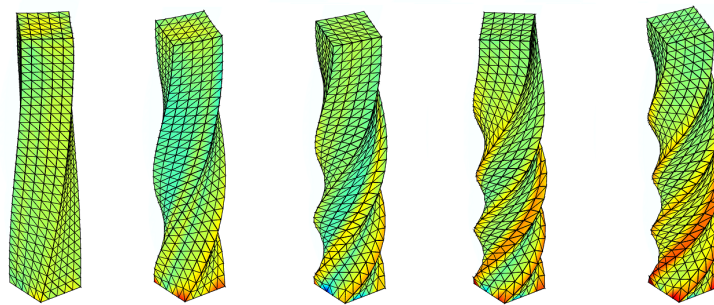


Figure 1: Various snapshots for a twisting column-like deformable structure.

### References

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