

STABILISED ALE TRANSPORT OF SCALAR INTERNAL VARIABLES IN ROLLING PROBLEMS

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ABSTRACT

In the framework of an Arbitrary Lagrangian–Eulerian (ALE) description of rolling problems, the treatment of inelastic material behaviour requires special care, as history-dependent quantities must be transported through a spatially fixed mesh. The challenge is to accurately follow the evolution of material state variables associated with material particles moving through the computational domain.

While several approaches have been proposed in the literature [1], including integration along concentric material paths and stabilised transport schemes such as time-discontinuous Galerkin (TDG) methods [2], a robust and modular implementation within an ALE framework remains nontrivial.

The present work focuses on the development and verification of a stabilised finite-element formulation for the transport of scalar internal variables, represented by an equivalent inelastic strain measure, within an ALE-based rolling framework. The scalar evolution is updated locally using an implicit Euler step and subsequently transported in the ALE framework by solving a stabilised finite-element transport problem.

The formulation is implemented within Abaqus using user-defined elements (UEL) to describe the ALE kinematics, while the nonlinear viscoelastic–hyperelastic material response is provided via a UMAT. The resulting modular workflow enables a consistent coupling between material evolution and kinematic transport and provides a sound basis for future numerical verification and extensions towards tensor-valued internal variables and contact formulations.

REFERENCES

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