ICNAAM 2024
16th Symposium on Recent Trends in the Numerical Solution of Differential Equations

Energetic BEM for frictional contact problems in elastodynamics

A. Aimi*, G. Di Credico, H. Gimperlein

Abstract

This work investigates the Energetic Boundary Element Method (BEM) [1] applied for the numerical solution of the elastodynamic wave equation with nonlinear contact boundary conditions, exploring the frictional dynamics at the contact interface.
It relies on recent advances on time-domain BEM for elastodynamics [2] and extends a preliminary study [3] for the frictionless case to the full contact model.
The differential problem at hand, equipped by nonpenetration conditions and frictional conditions opposite the tangential motion along the contact interface and by standard Dirichlet/Neumann conditions on the remaining part of the boundary, can be rewritten as an equivalent mixed formulation. This latter involves the Poincaré-Steklov operator and a set of Lagrange multipliers over the boundary of the physical domain. The mixed problem is then solved combining space-time BEM with the Uzawa algorithm.
The method is theoretically analysed for Tresca friction. It is applied to polygonal and curved geometries in 2D, exploring both unilateral and two-body contact simulations, with realistic elastodynamic parameters and both Tresca and Coulomb friction.
Numerical results confirm stability, energy conservation and convergence.

References

[1] A. Aimi, G. Di Credico, M. Diligenti, C. Guardasoni, *Highly accurate quadrature schemes for singular integrals in energetic BEM applied to elastodynamics*, Journal of Computational and Applied Mathematics **410** (2022), 114186.

[2] A. Aimi, G. Di Credico, H. Gimperlein, E. P. Stephan, *Higher-order time domain boundary elements for elastodynamics – graded meshes and hp-versions*, Numerische Mathematik **154** (2023), 35-101.

[3] A. Aimi, G. Di Credico, H. Gimperlein, *Time domain boundary elements for elastodynamic contact*, Computer Methods in Applied Mechanics and Engineering **415** (2023), 116296.

---

* Alessandra Aimi, Department of Mathematical, Physical and Computer Sciences, Parco Area delle Scienze 53/A, 43124 Parma, Italy; e-mail address: alessandra.aimi@unipr.it