hp-BEM for Contact Problems and Extended Ms-FEM in Linear Elasticity

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Motivation

- Solving hp-BEM frictional contact problems with the mixed boundary element method is a challenging task in mechanics.
- Multiscale finite element methods have to be considered and play an important role in engineering and structural mechanics.
- The construction of the numerical basis functions have a big influence an capturing the fine scale features of the coarse elements in the multiscale finite element analysis.

Goals

- hp-BEM stabilized mixed boundary element formulation for frictional contact problems in linear elasticity.
- A priori and a posteriori estimates for the stabilized problem.
- Analysis of linear elastic heterogeneous materials.
- Coupling of extended multiscale FEM with standard BEM.

Methods

Stabilized mixed hp-BEM in linear elasticity. Use of Poincaré-Steklov operator and Gauss-Lobatto-Lagrange basis functions, stabilization is used to avoid the discrete inf-sup condition for the boundary element spaces. The concept of error estimates of residual type is used to derive an adaptive meshrefinement procedure coupled with local increase of polynomial degrees both for the non-stabilized and stabilized mixed BEM schemes.

A extended multiscale finite element method EmsFEM is presented for the analysis of linear elasticity heterogeneous materials. The idea of the method is to construct numerically the multiscale basis functions to capture the fine scale features of the coarse elements in the finite element analysis.

Results and Outlook

A priori and a posteriori error estimates are obtained for the boundary element Galerkin approximations of the boundary displacement and the boundary traction which is the Lagrange multiplier in our mixed method. The adaptive procedure described above is superior for the standard BEM with quasi-uniform mesh and fixed polynomial degree. Numerical experiments show that the error controled hp-adaptive Galerkin solutions are converging much later than the non-adaptive case (without stabilization).

The results obtained by the extended Ms-FEM converge to the reference values as the number of the coarse elements increases. We obtain a posteriori error estimate for the FEM/BEM coupling solution. The error estimator are of residual.

ViVaCE-Projects with strong Interaction

- Multiscale FEM for Rubber Friction on Rough Surfaces (P. Wagner)
- Application of Plasticity Models at the Contact Layer (C. Weißenfels)