Speaker: Célio Fernandes

Title

Elastic Elliptic Membrane Shells in Frictional Contact: Asymptotic and Numerical Analyses of Wear Phenomena

Abstract

We investigate the asymptotic behavior and numerical analysis of linearly elastic elliptic membrane shells with thickness 2ε, clamped along their lateral boundary and subject to frictional contact with a moving foundation along their lower face. Due to frictional interaction, material removal may occur at the interface, giving rise to wear phenomena. From an analytical perspective, we establish that the solution pair $(\boldsymbol{u}(\varepsilon), w(\varepsilon))$ of displacements and wear fields for the three-dimensional scaled variational contact problem converges, as $\varepsilon \to 0$, to a pair of limit functions $(\boldsymbol{u}, w)$ that solve a reduced two-dimensional variational problem. We rigorously characterize the distinct convergence topologies for in-plane and transverse displacements as well as the wear field. Complementarily, we provide a fully discrete numerical scheme for the problem, developed in the FreeFEM++ environment using an intrinsic (basis-free) formulation, reduction of order, penalization, and a Newton-type solution strategy. We derive a priori error estimates for displacements, stresses, and wear, and validate the theoretical convergence with respect to both the thickness parameter ε and mesh size h. Numerical experiments illustrate the accuracy and robustness of the scheme, and as a practical application, we present a simulation of tire wear during braking on a road surface.