Finite element method for starved hydrodynamic lubrication with film separation and free surface effects

This paper proposes a numerical method for determining the evolution of lubricant film thickness and pressure in partially and fully flooded regions of a hydrodynamic contact between two non-conformal rigid surfaces. The proposed method accounts for the classical Reynolds equation within the fully flooded region and for film separation with surface tension driven flow in the partially flooded region, while at the same time it resolves the a priori unknown boundary between the two regions. Additionally it deals with transitions between wetted, partially flooded regions to dry regions, where the film thickness is zero. Both pressure and film thickness fields are considered as unknowns to solve for in each time step and they are approximated through quadratic B-spline finite elements. The geometry of the gap between the rigid surfaces delimiting the lubricant is accounted for in the form of a unilateral contact condition. Appropriate complementarity conditions with respect to separation or no penetration and no slip between the lubricant and the rigid surfaces are enforced by means of a weighted residual formulation.

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