Finite Element Procedures for Virtual Tribology

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Abstract

The main purpose of this thesis is to use modern goal-oriented adaptive finite element techniques in order to improve the numerical simulation of tribology. Two novel adaptive finite element methods for the Reynolds thin film model, and Stokes model including cavitation are presented and their different strategies are compared. The algorithms are inspired by an analogy with the obstacle problem and the cavitation problem that we consider is written as a variational inequality considering in the formulation the fact that the lubricant cannot stand negative stresses induced by subatmospheric pressure. *A posteriori* error estimates and adaptive algorithms are derived, and numerical examples illustrating the theory are supplied.

The cavitation problem and calculations is introduced and put into historical and modern perspective. Modern thoughts and techniques around the oil-pocket idea in sheet metal forming are presented. The influence of oil pockets on the contact regime is assessed, and in particular the likely effect of oil-pocket-induced cavitation in order to produce lift, is discussed. The ultimate goal with the numerical simulation is to be able to optimize the surface structure so as to take advantage of cavitation effects in the lubricant.

Keywords: Tribology, Reynolds equation, Stokes equation, cavitation, FEM, adaptivity, variational inequality, penalty formulation, error estimation, residual, duality.