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ANALYSIS AND APPROXIMATION OF A VISCOELASTIC CONTACT PROBLEM WITH SLIP DEPENDENT FRICTION

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Abstract. We consider a mathematical model for the quasistatic bilateral contact of a viscoelastic body with a rigid foundation. The contact is modeled with Tresca's friction law with the friction bound depending on the total slip. We present the classical as well as variational formulations of the problem and establish the existence and uniqueness of a weak solution. We then turn to numerical approximations of the problem. For both spatially semi-discrete and fully discrete schemes we show the existence of the unique solution and derive error estimates.

AMS subject classification : 73F15, 73V25, 73V05, 49J40.

1. Introduction

We investigate a model for the process of bilateral, frictional contact of a viscoelastic body with a rigid foundation. We assume that time-dependent volume forces and surface tractions acting on the body vary slowly and therefore the accelerations in the system are negligible. Neglecting the inertial terms in the equation of motion leads to a quasistatic description of the process. The setting is such that there is no loss of contact between the body and the foundation. This type of processes is very common in industry, especially in motors, engines, and transmissions. The contact of the braking pads with the wheel, the tire with the road and the piston with skirt are just three simple examples. For this reason, considerable progress has been made with the modeling and analysis of contact problems.

An early attempt to the study of frictional contact problems within the framework of variational inequalities was made in [7]. An excellent reference on analysis and numerical approximations of contact problems involving elastic materials with or without friction is [18]. The mathematical, mechanical and numerical state of the art can be found in the proceedings [24]. The existence of weak solutions to quasistatic frictional contact problems for viscoelastic materials has been proved in [1, 2, 25, 26]. Numerical approximations including error estimates and convergence analysis for quasistatic viscoelastic frictional contact problems have recently been performed in [14, 15].