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Approximation and numerical realization of 3D quasistatic contact problems with Coulomb friction

J. Haslinger[a,∗], R. Kučera[b], O. Vlach[c], C.C. Baniotopoulos[d]

[a] *Department of Numerical Mathematics, Faculty of Mathematics and Physics, Charles University, Sokolovská 83, 186 75 Praha 8, Czech Republic*
[b] *Department of Mathematics, VŠB-TU Ostrava, Tř. 17. listopadu 15, 708 33 Ostrava-Poruba, Czech Republic*
[c] *Department of Applied Mathematics, VŠB-TU Ostrava, Tř. 17. listopadu 15, 708 33 Ostrava-Poruba, Czech Republic*
[d] *Department of Civil Engineering, Aristotle University, Thessaloniki, Greece*

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Abstract

This paper deals with the full discretization of quasistatic 3D Signorini problems with local Coulomb friction and a coefficient of friction which may depend on the solution. After a time discretization we obtain a system of static contact problems with Coulomb friction. Each of these problems is solved by the T-FETI domain decomposition method used in auxiliary contact problems with Tresca friction. Numerical experiments show the efficiency of the proposed method.
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Keywords: Contact problems; Coulomb friction; Domain decomposition methods

1. Introduction

Contact problems represent a special branch of mechanics of solids which analyzes the behavior of loaded, deformable bodies being in a mutual contact. Due to non-penetration and friction conditions, the resulting problems are highly non-linear. Both, unilateral and friction phenomena depend on time. Therefore contact problems with friction should be defined as a dynamical process. If however applied forces vary slowly in time, inertia of the system can be neglected and one can use a quasistatic approximation. This, together with a dependence of friction coefficients on the solution, typically arises in geomechanics (modelling of a movement of tectonic plates, prediction of earthquakes). Applied forces are the functions of time, the Coulomb law of friction uses the velocity of the tangential contact displacements and the coefficient of Coulomb friction itself may depend on the modulus of the previously mentioned velocities (see [6]). This paper extends results of [14] from two (2D) to three (3D) space dimensions. Let us note that this extension is not straightforward since the friction conditions are more involved in 3D.

Using a three-step finite-difference approximation of the time derivative we arrive at a sequence of static contact problems with (local) Coulomb friction whose solutions are defined by using a fixed point approach. Thus the method of successive approximations turns out to be a natural tool for the numerical solution. Each iterative step is represented

∗ Corresponding author.
E-mail addresses: Jaroslav.Haslinger@mff.cuni.cz (J. Haslinger), radek.kucera@vsb.cz (R. Kučera), oldrich.vlach2@vsb.cz (O. Vlach), ccb@civil.auth.gr (C.C. Baniotopoulos).

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