ON THE INTERACTION OF FRICTIONAL SLIDING CONDITIONS WITH BIFURCATION PHENOMENA IN HYPERELASTIC STEADY STATE ROLLING CALCULATIONS†

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Many analysis procedures in the tire industry make use of finite element formulations for steady state rolling in large deformations. Incorporation of frictional conditions into such models is particularly challenging, given the intricate dynamics of this seemingly straightforward structural system. In such analyses, the kinematics of the problem are usually described in an arbitrary Lagrangian Eulerian manner, where the frame of reference is attached to the hub of the cylindrical wheel (assumed to move at constant velocity under steady state conditions). The problem may involve nonlinear frictional contact, and includes material and geometric nonlinearities emanating from a hyperelastic constitutive law (Mooney-Rivlin is a common choice here).

The occurrence of limit and bifurcation points is a common phenomenon in nonlinear structural mechanics [1], and such points are known to exist in particular in spinning cylinder problems even in the absence of contact conditions [2]. When such conditions are also included into the model, contact-induced standing waves might appear [3].

This paper addresses the problem of the identification of limit and bifurcation points in the rolling cylinder problem, and examines the relationship of these points to the development of effective iterative schemes for the frictional rolling problem. Different formulations for enforcing the contact constraints are compared. We further investigate the nature of the bifurcation points that are encountered and the effect of the numerical discretization on the stability and convergence of algorithms used to compute steady state equilibria.

References

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