8th. World Congress on Computational Mechanics (WCCM8)
5th European Congress on Computational Methods in Applied Sciences and Engineeering (ECCOMAS 2008)
June 30 –July 5, 2008
Venice, Italy

MODELING OF HIGH FRICTION CONTACT PROBLEMS WITH OR WITHOUT THIRD BODY

*** Z.-Q. Feng, J.-M. Cros and C. Renaud**

Laboratoire de Mécanique et d'Energétique d'Evry, Université d'Evry
40 rue du Pelvoux, 91020 Evry, France
feng@iup.univ-evry.fr - http://gmfe16.cemif.univ-evry.fr:8080/∼feng

Key Words: *Contact and friction, Third body, Computational mechanics, Rubber materials.*

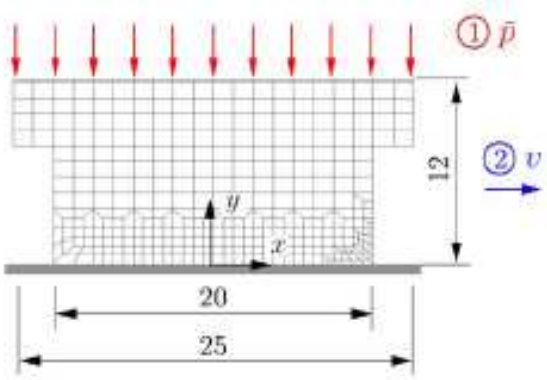
ABSTRACT

Friction problems involving rubber components are frequently encountered in industrial applications, especially in tire design and development. Their treatment within the framework of numerical simulations is often performed by means of the Finite Element Method (FEM). A large number of algorithms for the modeling of contact problems by the finite element method have been presented in the literature. See for example the monographs by Wriggers [1] and Laursen [2], and the references therein. The bi-potential method proposed by de Saxcé and Feng [3] turns out to be particularly efficient for the treatment of quasi-static frictional contact problems [4]. Recently, this method has been successfully applied to the modeling of dynamic contact problems [5]. A first order implicit scheme is applied to integrate the equations of motion.

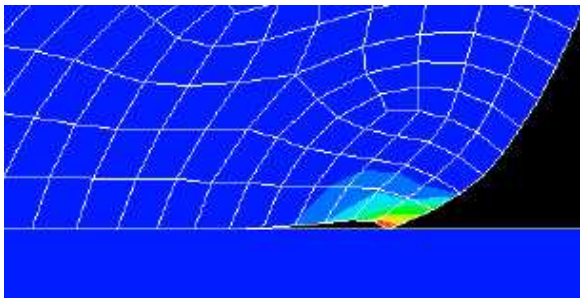
This present work focuses on the modeling of the contact problem between a rubber tread block and a rigid surface. We show the difficulties of an implicit finite element method when applying a high friction coefficient.

We consider the contact between a rubber block and a rigid surface with friction as illustrated in Fig. 1(a). The finite element simulation is performed in two steps. In the first step, a uniformly distributed pressure p is applied to the top surface of the rubber block. Under maintenance of this pressure, the block is moved in horizontal direction at constant sliding velocity v in the second step. This problem was proposed and solved by Hofstetter *et al.* [6] by using the explicit finite element code ABAQUS/Explicit. Our work is to solve the similar problem by an implicit finite element method in which a system of equations needs to be solved. We observe difficulties when applying a high friction coefficient (e.g., $\mu > 1.0$). A high stress concentration appears at the right lower corner of the block, as shown in Fig. 1(b). It is also noted that in this zone, the stiffness matrix becomes singular, which leads to divergence of the solution procedure .

We also solve the problem when taking into account the third bodies between the rubber block and the rigid surface as shown in Fig. 2.



(a)



(b)

Figure 1: Contact between a rubber block and a rigid surface

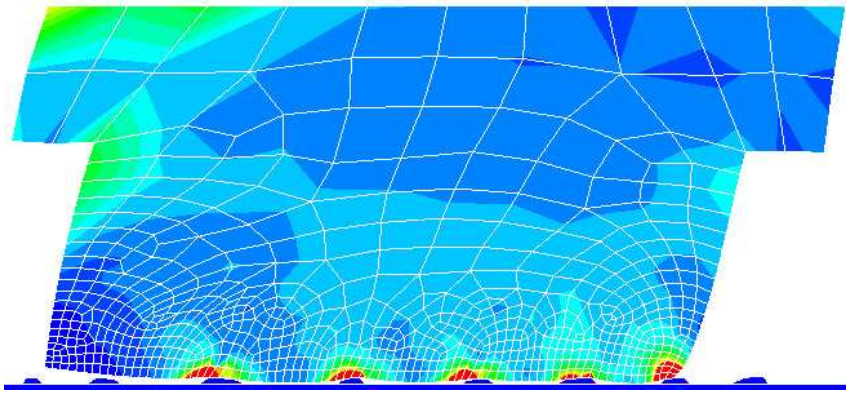


Figure 2: von Mises stress with third bodies

References

[1] P. Wriggers. *Computational contact mechanics*. John Wiley & Sons, 2002.

[2] T. A. Laursen. *Computational contact and impact mechanics: Fundamentals of modeling interfacial phenomena in nonlinear finite element analysis*. Springer Verlag, 2002.

[3] G. de Saxcé and Z.-Q. Feng. The bi-potential method: a constructive approach to design the complete contact law with friction and improved numerical algorithms. *Mathematical and Computer Modeling*, 28(4-8):225–245, 1998.

[4] Z.-Q. Feng, F. Peyraut, and N. Labed. Solution of large deformation contact problems with friction between Blatz-Ko hyperelastic bodies. *Int. J. Engng. Science*, 41:2213–2225, 2003.

[5] Z.-Q. Feng, B. Magnain, and J.-M. Cros. Solution of large deformation impact problems with friction between Blatz-Ko hyperelastic bodies. *Int. J. Engng. Science*, 44:113–126, 2006.

[6] K. Hofstetter, Ch. Grohs, J. Eberhardsteiner, and H.A. Mang. Sliding behaviour of simplified tire tread patterns investigated by means of FEM. *Computers & Structures*, 84:1151–1163, 2006.