A local multi-physical approach to model braking materials

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Summary: Local investigations are managed to understand the multi-physical complexity of braking materials. After a determination of the Representative Elementary Volume, measures of friction, damage and temperature are related to global solicitations and the deceleration. The impact of wear on the different equilibrium is also presented.

Introduction

The relative motion of two bodies in contact is the seat of several dissipative phenomena. In particular, part of the mechanical energy necessary to rub bodies against each other is converted into thermal energy (from 80 to 95% according to the literature [1]). Under dry contact conditions, this conversion can lead to hot spot localization, thermoelastic instabilities, etc [2]. The literature proposes a large variety of analytical models trying to represent the contact complexity [3] but it appears that there are only few models accounting for the dynamic evolution of the contact, leading to the creation of an interfacial layer composed for the most part of the transformation and the degradation of debris particles issued from the bodies in contact. This layer, usually called the third body in reference of the two bodies in contact [4], is well known to its mechanical roles (velocity accommodation, load transmission,...) but less for its thermal ones.

With the development of discrete element methods (DEM) [5] and their extensions to thermo-mechanical behavior of contact interface, it is possible to analyze numerically the life of a contact. Several results have been observed [6] as, for example, the localization of the maximal temperature within the thickness of the third body as a function of its internal cohesion. Nevertheless, the approach stays at the scale of the third body, and the influence of first bodies is related to some specific thermal boundary conditions.

Based on recent works [7], a new reflection on the wear process including mechanical and thermal effects, is proposed. Using an extended discrete element approach, a discussion is proposed around the evolution of friction, temperature and wear in terms of energy balance.

Numerical Framework

The method used to simulate evolution of a discrete equivalent continuous media is the Non-Smooth Contact Dynamics (NSCD) approach, developed by Moreau and Jean [5]. Recently, the approach has been extended and used as a mesh-less approach to model equivalent continuous media under tribological solicitations where cohesive zone models (CZMs) [8] have been used to confer with the whole packing a continuous behavior (cf. Figure 1) equivalent from a mechanical and a thermal point of view [7, 9].

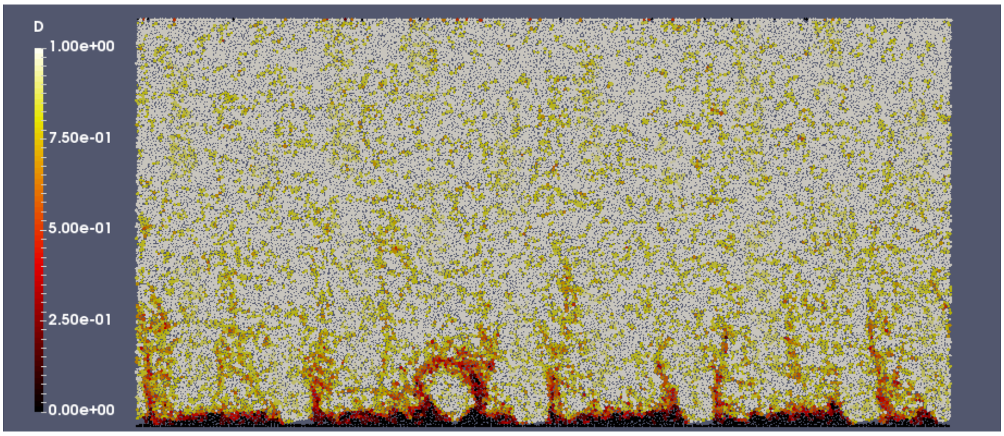

Figure 1: Evolution of the damage in a discrete structure

Results

Among the different results, impact of debris properties will be presented and how the internal cohesion of the tribological layer can be related to damage processes. Moreover, the introduction of wear flows are also discussed. They underline the fact that a controlled wear flow could be benefit for the evolution of the global damage of the REV.

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