



# Semi-analytical model for coated contacts. Fretting wear simulation

Jerbi Hana, Daniel Nélias, Marie-Christine Baietto

## ► To cite this version:

Jerbi Hana, Daniel Nélias, Marie-Christine Baietto. Semi-analytical model for coated contacts. Fretting wear simulation. 42nd Leeds-Lyon symposium on Tribology, Surface and interfaces mysteries at different scales, Sep 2015, Lyon, France. hal-01952469

**HAL Id: hal-01952469**

**<https://hal.science/hal-01952469>**

Submitted on 6 Jul 2021

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution 4.0 International License

## SEMI-ANALYTICAL MODEL FOR COATED CONTACTS. FRETTING WEAR SIMULATION

Hana Jerbi<sup>a\*</sup>, Daniel Nélías<sup>a</sup>, Marie-Christine Bailetto<sup>b</sup>

<sup>a\*</sup>hana.jerbi@insa-lyon.fr

<sup>a, b</sup>LaMCoS, INSA-Lyon, CNRS UMR5259  
F69621 Villeurbanne, France

### ABSTRACT

This paper presents a fast and robust contact model based on semi-analytical method that is employed for the simulation of wear. This model takes into account the effect of cyclic wear induced from fretting solicitations under gross slip conditions.

### INTRODUCTION

The blade/disk interface is one of the most critical contacts for fretting problem. In order to protect engine components from fretting, blade/disk contact surfaces are usually covered by a thick and soft coating. Important researches have been carried out in order to understand and quantify the damage in this contact. Many formalisms have been proposed for quantitative approach of wear. More than 300 have been identified by Meng and Ludema [1] in 1995, resting on different applications [2,3]. This research is based on previous works [4,5] developed at LaMCoS. An energy theory of wear, inspired by the Archard's theory [6], is selected as it is very simple to implement. The objective is to perform wear prediction using semi analytical computational methods.

### FRETTING WEAR

#### Methodology to Predict Wear

Several successive steps are solved:

- Contact solution between the two bodies, with contact pressure distribution versus discretization points and contact area as outputs,
- Computation of the frictional dissipated energy density.  $E_d$  at each point, corresponding to the product of the tangential stress with the sliding distance.

$$E_d = \sum_{k=1}^N \mu \cdot p^k \cdot s^k \quad (1)$$

- Quantification of the wear depth  $\Delta h$  for one cycle, calculated at each point according to an appropriate wear law.

$$\Delta h = f(E_d) = \alpha \cdot S \cdot \sum_N \delta_0(N) E_d(N) \quad (2)$$

- Determination of the wear cycle increment  $\Delta N$ , obtained from the relation between the maximum value of the wear depth to be removed at each iteration and the maximum increment of wear depth.

$$\Delta N = H_{\max} / \max(\Delta h_N) \quad (3)$$

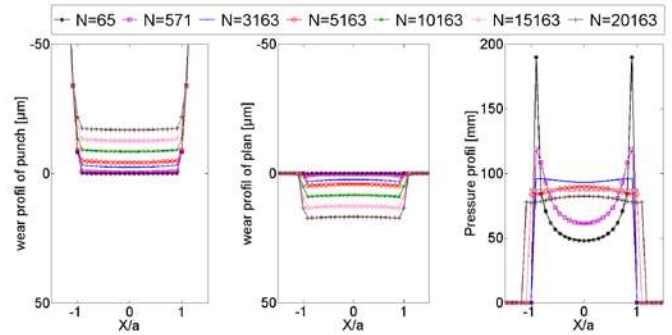
- Updating of the worn geometry. The value of  $\Delta h$  is then multiplied by the wear cycle increment  $\Delta N$ , and the geometry is updated before next contact solution and wear calculation.

$$h_N = \Delta N * \Delta h_N \quad (4)$$

$$N = N + \Delta N$$

### Results

Figure 1 presents the evolution of wear in terms of contact pressure and wear profile history, for a rectangular flat punch rubbing against a flat surface.



EVOLUTION OF PRESSURE DISTRIBUTION AND WEAR PROFILE VERSUS N (NUMBER OF CYCLES) FOR THE COATED CONTACT. Bilateral wear.

### REFERENCES

- [1] Meng, H., and Ludema, K., "Wear models and predictive equations: their form and content". Wear, 181-183, (1995), pp. 443-457
- [2] Fouvry, S., Kapsa, P., and Vincent, L., "Quantification of fretting damage". Wear, 200, (1996), pp.186-205.
- [3] Paulin, C., "Etude de l'endommagement du contact multicouche aube/disque sous chargement de fretting : impact des sollicitations variables et de la dimension du contact". Thèse de doctorat, Ecole Centrale de Lyon, (2006).
- [4] Gallego, L., and Nélías, D., and Jacq, C., "A comprehensive method to predict wear and to define the optimum geometry of fretting surfaces". ASME Journal of Tribology, 128(3), (2006), pp.475-485.
- [5] Gallego, L., and Nélías, D., "Modeling of fretting wear under gross slip and partial slip conditions". ASME Journal of Tribology, 129(3), (2007), pp.528-535.
- [6] Archard, J. F., "Contact and rubbing of flat surfaces". J. Appl. Phys., 24, (1953), pp.981-988.