

## Numerical analysis of a 3D hydrodynamic contact

Costin Caci<sup>1</sup>, Etienne Decencière

<sup>1</sup> *CMM, École des Mines de Paris  
35, rue Saint-Honoré  
77305 Fontainebleau, France  
Tel. +33 1 64 69 48 00  
Fax. +33 1 64 69 47 07  
E-Mail: Costin.Caciu@cmm.ensmp.fr*

### SUMMARY

We study here the numerical analysis of a hydrodynamic contact in a particular configuration: the 3D incompressible viscous flow of a fluid dragged by a smooth plate over a rough surface. The mathematical model takes into account and discretises the local topography of the rough profile. The simulation outcome will be the 3D velocity and pressure fields of the fluid film within the contact borders. This work is limited to the study of numerical resolution methods working solely in finite differences. The algorithms will be tested by analysing and comparing their results with analytically known flows. Copyright © 2006 John Wiley & Sons, Ltd.

KEY WORDS: friction; hydrodynamic lubrication; incompressible flow; Navier-Stokes equations; CFD

### 1. INTRODUCTION

Energy loss and friction phenomena have always been domains of major interest for the scientists. In this context, the present work tries to characterise, numerically, the tribological properties of rough surfaces in a particular configuration: the 3D incompressible viscous flow in the hydrodynamic contact between a smooth plate and a rough surface. The geometry of the contact is strongly related to the physical parameters of the flow. Generally, in such conditions, the fluid film is relatively thin but always thicker than the surface roughness characteristic size, so that no elastic contact occurs.

This study is performed within the framework of a friction prediction tool for hydrodynamic contacts. First, this tool will enable us to analyse in depth the flows in hydrodynamic bearings and to obtain significant results concerning the influence of the surface topography on the contact tribological performance. Furthermore, the tool may be used, as objective function, to perform topography optimisation for friction reduction issues.

The surfaces studied are available as 2D topographic images. Image processing tools have been developed in order to extract and analyse the topographic characteristics of such rough surfaces [14]. Nevertheless, their application is limited; the physical phenomena occurring in the hydrodynamic contact are complex, and global parameters like drag or lift are difficult to estimate from the topographic analysis of the surface alone.

Consequently, we propose a 3D hydrodynamic contact model; the inputs will be the rough surface as a 2D image and the physical and geometrical parameters; the fluid flow in the defined volume will