



**HAL**  
open science

## Direct numerical simulation of sliding rough contact

Alain Le Bot, Modeste Assemien

► **To cite this version:**

Alain Le Bot, Modeste Assemien. Direct numerical simulation of sliding rough contact. Contact Mechanics International Symposium, May 2024, Lyon, France. hal-04815436

**HAL Id: hal-04815436**

**<https://hal.science/hal-04815436v1>**

Submitted on 2 Dec 2024

**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.

# Direct numerical simulation of sliding rough contact

A. Le Bot and M. Assemien

Laboratory of tribology and dynamics of systems UMR CNRS 5513, Ecole centrale de Lyon, 36, av. Guy de Collongue 69134 Ecully, France.

We have performed a direct numerical simulation of the vibration induced by the sliding friction in rough surfaces. The configuration is the following. A small rigid cube is set down on a horizontal large plate. The bottom face of the cube and the top face of the plate have random Gaussian surfaces of roughness  $17 \mu\text{m}$  and correlation length  $80 \mu\text{m}$ . The cube slides at a constant speed  $V$  in the range  $3 - 500 \text{ mm/s}$ . The gravity maintains the contact. During the sliding, mechanical contacts between surface asperities induce a vibration of the thin elastic plate.

In Figure 1 is shown the evolution of the vibrational level  $L_v$  versus sliding speed  $V$ . We found that below  $V_T = 120 \text{ mm/s}$ , the RMS vibrational speed  $v$  in the plate evolves as  $v \propto V^\beta$  with  $\beta = 0.75$ . Beyond this transitional sliding speed,  $v$  follows the same power law but with the exponent  $\beta = 0.1$ .

The analysis of the total contact force between the cube and the plate reveals the existence of two regimes. Below  $V_T$ , the contact is always maintained (creeping regime) and the mean contact force is equal to the cube weight. But beyond  $V_T$ , the contact force may reach zero and losses of contact appear and (flying regime). The first losses of contact appear at a sliding speed well predicted by a unit value of Froude's number  $Fr = V_T^2/Rg$  where  $g = 9.81 \text{ m/s}^2$  and  $R = 30 \mu\text{m}$  is the radius of curvature of the mass centre of the cube (estimated in quasi-static condition).

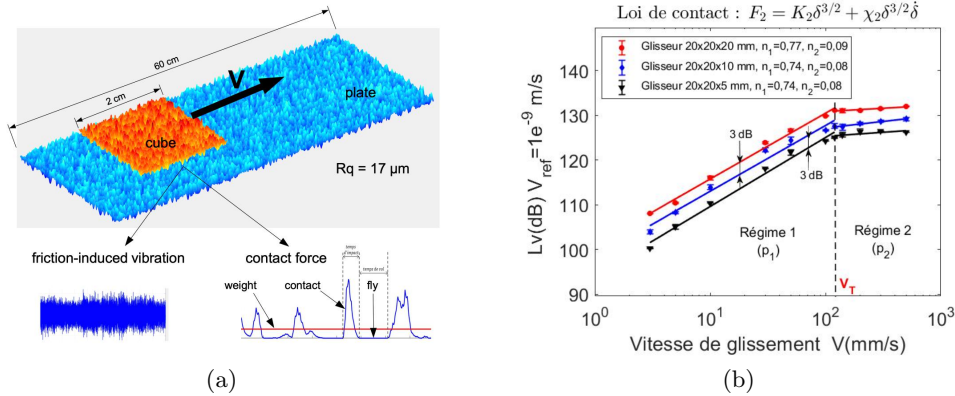


Figure 1: Friction-induced vibration by rough surfaces in sliding contact: (a) finite element mesh in the undeformed configuration, (b) evolution of vibrational level versus sliding speed for three thicknesses of the cube.

## References

- [1] H.B. Abdelounis, A. Le Bot, J. Perret-Liaudet, and H. Zahouani, An experimental study on roughness noise of dry rough flat surfaces, *Wear*, 268:335-345, 2010.
- [2] V.H. Dang, J. Perret-Liaudet, J. Scheibert, A. Le Bot, Direct numerical simulation of the dynamics of sliding rough surfaces, *Computational mechanics*, 52:1169-1183, 2013. *Phys. Rev. E*, 99:023004, 2019.
- [3] M. Assemien, *Vibrations induites par la dynamique des interfaces multicontact : expérimentation et simulation numérique*, thèse de doctorat de l'Ecole centrale de Lyon membre de l'université de Lyon, 2023.