A NEW METHOD TO EVALUATE THE ENERGY DISSIPATION RESPONSE OF SURFACES UNDER FRETTING CONDITION

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ABSTRACT

Non-permanent mechanical assemblies subjected to vibrations provide complex study cases for tribology, especially when submitted to a wide spectrum of vibrations, and multi-directional loads. The interfaces are mostly surface contacts, with local normal load widely influenced by shape and waviness surfaces defects.

The assessment of the durability of such structures is linked to the fretting phenomenon which can induce a mix of cracking and wear damage. The characterization of such a behavior requires an overwhelming number of tests. That's why studies essentially focus on the identification of the main damage mechanisms and critical load cases in those structures in order to perform a reduced number of significant tests, and implement a comparative evaluation of the performances of various materials pairs, coatings of lubricants.

The damping ability of mechanical assemblies turns out to be a dimensioning issue in a context of more and more compliant structures, since energy dissipation in contacts often leads to surface degradation, then loss of functionality. Energy based parameters have been related to wear rate for decades, and refined to work even under complex loading conditions [1], but typical damage-oriented experimental methods provide insufficient tools to evaluate the damping properties of the surfaces and their evolution caused by cumulative damage.

In this study we propose to use a parameter introduced in recent PhD work [2] in which the behavior of the contact surface is related to that of the test bench. This parameter, $A_{el,}$ is calculated from force-displacement fretting cycles, and is defined as the ratio of the dissipated energy E_d by the maximum elastic potential energy of the mobile assembly of the tribometer $E_{el\text{-}max}$. It was first shown that this parameter could be used as a sliding regime transition criterion.

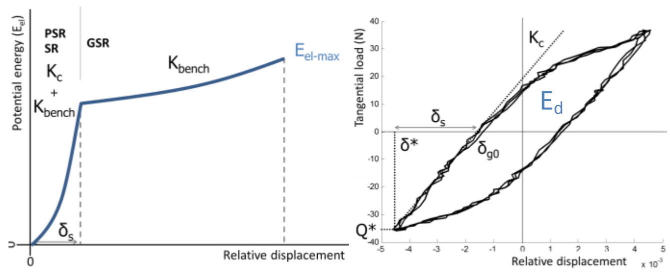

Fig.1 Definition of $A_{el} = E_d / E_{el\text{-}max}$ [2]

Experimental tests based on imposed tangential force piloting (for damage cycling) and tangential force sweeps at various moments of the cycling (for characterization purpose) have been analyzed. These sweeps have similar goals as shock hammer tests in vibration testing. The evolution of this parameter with the tangential applied force can quantify the dissipation behavior of the surface for a wide range of loads, not only the one applied during the actual damage test. An analytical modelling of this parameter for a ball on plane contact configuration [3] has also been studied, and qualitatively compared to experimental results to highlight the influence parameters.

This study globally aims to investigate the potential uses of this parameter as a tool to assess the damping potential of different tribological design choices.

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