Accepted Manuscript

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PII: S0997-7538(17)30113-4

DOI: 10.1016/j.euromechsol.2017.06.010

Reference: EJMSOL 3451

To appear in: *European Journal of Mechanics / A Solids*

Received Date: 8 February 2017

Revised Date: 12 May 2017

Accepted Date: 22 June 2017

Please cite this article as: Pan, W., Li, X., Wang, L., Guo, N., Mu, J., A normal contact stiffness fractal prediction model of dry-friction rough surface and experimental verification, *European Journal of Mechanics / A Solids* (2017), doi: 10.1016/j.euromechsol.2017.06.010.

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ARTICLE INFO

Article history:

Received

Keywords:

Normal contact stiffness

Fractal theory

Friction factor

Three-dimensional fractal

Rough surface

ABSTRACT

The normal contact stiffness is one of important dynamic parameters and the accurate construction of its model is conducive to subsequent modeling and analysis of dynamics on whole machine. However, most of previous normal contact stiffness models neglect the influence of friction factor of rough surfaces. Given that the friction factor of rough surfaces has a significant influence on the structural dynamic characteristics, in this paper, a normal contact stiffness fractal prediction model of dry-friction rough surface considering friction factor based on three-dimensional fractal function is established. And the given (power spectrum density) PSD function is used to identify two important fractal parameters, three-dimensional fractal dimension *D* and the fractal roughness *G*. The analysis of numerical simulation indicates that the normal contact stiffness monotonically increases and decreases respectively with the three-dimensional fractal dimension and fractal roughness increasing; it increases with the actual contact area and the maximum contact area of asperity increasing; it tends to decrease on the whole with the friction factor increasing, which turns out to be linear deduction firstly and then exponential deduction. In addition, the friction factor has an important influence on natural frequency of the whole structure. This paper verifies the validity of the established model by experiment and the normal contact stiffness of surface should be considered in the dynamics modeling of the whole machine.

1. Introduction

After being machined, from the macro perspective, the surface of component is smooth, while from the micro perspective, that presents a lot of asperities, that is to say, the surface topography of component is rough. The rough surface topography has an important influence on the friction, fatigue and vibration noise of joint surfaces. After observing the surface topography of metal(Ling,1987; Gagnepain et al.,1986; Majumdar and Tien,1990; Majumdar and Bhushan,1991), scholars find that under different measurement scales, the surface topography is characterized by the statistical self-affinity and self-similarity, so the fractal theory (Mandelbort,1982) is introduced and is widely used in the description and modeling of rough surface topography. The static and dynamic characteristics of the whole machine can be analyzed and predicted by accurate modeling of characteristic parameters (mainly be contact stiffness and contact damping) of rough joint surfaces, which is a key technique in the process of general mechanical development and analysis.

The normal contact stiffness is one of the important dynamic characteristic parameters of joint surfaces, which can be obtained by experiment and theoretical calculation. In order to avoid making a lot of experiments on the whole structure, from the perspective of microscopic rough topography and microscopic contact behavior, people explore to build the contact stiffness prediction model theoretically. Until now, the research on contact stiffness prediction model is divided into two types: one is numerical modeling, mainly the construction of FEM contact model (Tian et al.,2011; Liu et al.,2011; Xiao and Shao,2015; Jana et al.,2017;

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