MICROGEOMETRY ON SURFACE TREATED PART :

MEASUREMENT AND INFLUENCE

Agnes Fabre, Arts et Métiers ParisTech, MSMP Laboratory, 2, Cours des Arts et Métiers, 13617 Aix-en-Provence, F

Abstract

This keynote is a review of previous works on the measurement of the roughness, on the influence of roughness on the fatigue lifetime of gears, on an investigation.

This presentation deals first with the development of measurement standard for three-dimensional roughness. This first work was done by A. Fabre, J. Vincenti (Arts et Métiers PArisTech, MSMP lab.) and S. Raynaud (INSA de Lyon).

Using contact or non-contact facilities (contact stylus, confocal microprobe, interferometry), three-dimensional roughness is quantified by the calculation of pertinent parameters defined by the international standard EN ISO 25178-3:2010. The quantification of these specific parameters is required with a good accuracy because of the optimized design of parts. Roughness must be qualify and quantify with pertinent and sensible parameters in order to correctly define the capability and in consequence the integrity of the surface, for example in the contact zone on some mechanical parts. Previous investigations were published about the influence of measurement on particular parts [1, 2]. Contact and non-contact facilities, different conditions of measurement and different software of data treatment can influence the results. With the new international standards and the possibility to use non-contact apparatus to qualify normalized roughness, the impact of the instrumental choice on the results must be analysed.
In continuity with the previous studies [1,2], in this current study, a development of a measurement standard is conducted in order to qualify roughness by different apparatus. Roughness is characterized on this new standard with confocal, and interferometric apparatus and contact apparatus. Analysis of roughness parameters is investigated in order to detect the influence of different methods of measurement.
On the other hand, because of the particular shape of the standard sample developed, measurements are qualified on different zones on the standard sample. It is corresponding to different angular positions of the surface measured with the reference of measurement. This analysis is conducted in order to qualify if the incidence of the position of the measured area is quite similar using different apparatus.

The second part of this presentation deals with the influence of roughness on fatigue damage : the micropitting. This second work was done by A. Fabre, L. Barrallier, M. Desvignes (Arts et Métiers ParisTech, MSMP lab.) and H.P. Evans, K. J. Sharif (Cardiff University, Tribology and Contact Mechanics Group).
Micropitting is considered to be fatigue damage induced by variation of mechanical loading close to the contact zone for example on gear teeth due to surface roughness effects. In order to improve fatigue lifetime, new superficial treatment can be investigated to achieve sufficiently high yield strength or endurance, but it must be developed with the associated control of surface roughness. Some studies that have

been developed in order to create a model of the effect of real initial roughness on the damage mechanism are reported on scientific literature. In our first original study [3], a generic rough profile was developed. This parametric approach was followed in order to define the main geometrical parameters that affect the fatigue lifetime. The superficial loading was given for different values of roughness parameters on one rough surface sliding against a smooth surface.
In complementary to this first study, the current study is conduced in the case of meshing of two rough teeth. Seven parameters are used to describe the microgeometry of the rough surface. The method is based on the model of surface loading given by two-dimensional approach with the elasto-hydrodynamic code developed by Holmes et. al. [4]. Using the plane strain hypothesis, an analytical model is developed to assess the sub-surface mechanical loading on the rough gear teeth in the contact zone [5]. The load history is obtained for materials points beneath the surface to a depth. The Crossland criterion is used to qualify the points where fatigue damage based on quenched and tempered 32CrMoV13 material properties.
Furthermore, the influence of gaseous nitriding on this steel is investigated. The prediction of fatigue life is conducted taking into account the modification of the material properties due to this thermo-chemical treatment.

The third part of this presentation deals with an investigation in order to characterize the damage induced by the running-in stage. This third work was done by A. Fabre, S. Jégou, L. Barrallier (Arts et Métiers ParisTech, MSMP lab.). This study is conducted in order to complete this previous study about the influence of roughness on surface fatigue damage taking the plastic deformation due to running-in into account. Moreover the damage concerning a large volume of material is difficult to correlate directly with a global physical variable. Directly linked with the local plastification of material, damage can be described with the notification of local changes in crystallites with the increase of dislocations. The peak of X-ray diffraction is sensible to the dislocation density [6] and to the structure of dislocations.

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