Using identification method to measure coefficient of friction in dovetail contact – WTC 2021, Lyon

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The present study investigates the possibility of measuring *in-situ* the coefficient of friction (COF) in a dovetail geometry, accounting for the blade/disk contact of helicopter engines, with Digital Image Correlation (DIC) followed by Finite Element Method Updating (FEMU) technique. The significance of numerical COF on lifetime prediction compels us to develop accurate derivation method. A dovetail specimen is subjected to static uniaxial tension and thermal load. The displacement field is measured near contact with DIC technique. Resulting shear strain field enables estimation of the mean numerical COF by using FEMU. Impact of surface quality over the COF is examined.

Keywords: fretting, dovetail, coefficient of friction, DIC, FEMU

1. Introduction

Fretting-fatigue is a critical damaging process found in many industrial applications, such as blade/disk contact of helicopter engines. To estimate and reduce impact on structure lifetime, efficient numerical models must be deployed. Finite Element Method (FEM) is often used. However, the numerical COF plays a significant role on the computed contact stresses, and thus on the estimated fatigue life. Accurate estimation of this parameter is then required to avoid over-conservative model. Multiple experimental and analytical COF derivation methods related to fretting exist [1], but are not completely satisfying as they operate under specific contact conditions.

This study aims to develop an *in-situ* measuring methodology of the COF of a dovetail specimen under tension with DIC and FEMU techniques in order to refine numerical models with explicit data and to retrieve rich information about frictional behavior as close as possible to the contact interface.

2. Methods

Experiments were conducted under static uniaxial tension, at room and high temperatures. The thermal load was applied via induction heating, which enables good visibility on the specimen. An inverse analysis was carried out by minimizing the error between experimental and numerical data. Adjusting numerical parameter to fit the experimental field measured by DIC allows estimation of the mean COF in the dovetail specimen.

2.1. Digital Image Correlation technique

Prior to the experiment, surface of specimens were coated and covered with speckles. The area of interest is 0.7 × 0.7 mm. 2D and 3D displacement fields were measured with 5 megapixel cameras.

2.2. Numerical Results

FEM model of the dovetail joint with appropriate mesh [2] shows interesting evolution of in-plane shear strains near contact (Figure 1). Numerical displacement fields indicate that cameras are able to detect change in COF.

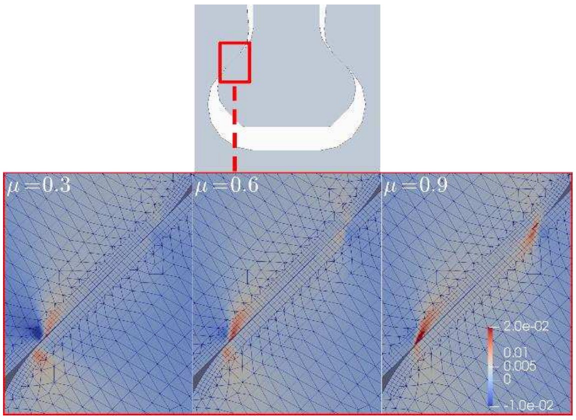

Figure 1: Shear strains on lateral face near contact interface for several COF μ

3. Discussion

FEMU allows estimation of COF in contact conditions very close to real world applications. This method has the advantage to be directly linked to the FEM software used for optimization. Furthermore, full sliding is not required, which is more representative of real conditions, as the mean COF can be estimated in partial slip conditions. Conclusive results will help refining numerical models by replacing the previously approximated numerical COF. Friction is a time-varying parameter, and this is especially true with fretting-fatigue loading, which is characteristic of the blade/disk contact. Therefore, adapting the present approach to fatigue loading could give interesting information about the evolution of the numerical COF in a dovetail contact.

4. References

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