NUMERICAL AND EXPERIMENTAL OPTIMIZATION OF SURFACE TEXTURES THROUGH THE ADJOINT METHOD

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INTRODUCTION

Among the several numerical optimization tools for engineering problems, the discontinuous adjoint method represents a promising and versatile technique, which can also be applied to the field of tribology[1,2]. In particular, the design of complex engineered surfaces, *e.g.* as textured ones, can thoroughly benefit from this method, as it allows dealing with a large number of degrees of freedom at low computational costs. In order to assess the applicability of this technique on the optimization of an actual tribo-system, this work investigates surface texturing in a twofold approach. Pin-on-disc experiments hereby complement numerical simulations, so that the effects of optimized textures can be compared to traditional texture designs and other numerical methods[3].

Adjoint method; Reynolds equation; Surface textures.

NUMERICAL APPROACH

The cornerstone of the adjoint method is represented by the computation of the sensitivity function, which relates the increment of the aim function (*e.g.* the load carrying capacity) with respect to the variation in the design parameters (*e.g.* shape and location of texture elements and operative conditions). Such computation is based on the governing equation, in our case the Reynolds equation with mass conserving cavitation[4]. Once the sensitivity function is known, it can be used to iteratively update the initial geometry until the desired (optimum) performance is achieved.

The optimization may run also under user-defined constrains in order to exclude trivial solutions or to account for possible manufacturing restrictions. Figure 1 shows, for example, the optimized textured surface of a pin. Due to the different values of gap height and pressure, texture elements in different positions also have a different optimal shape.

EXPERIMENTAL SET-UP

The numerically optimized surfaces are tested on a pin-on-disc tribometer with particular attention to the manufacturing precision of both the texture and the shape of the pin. For this reason, the textured pins are prepared through laser surface texturing, so that every texture element can have a different shape (see Figure 1). The so optimized surface will be subsequently compared to other ones resulting from traditional parametric optimization[3].

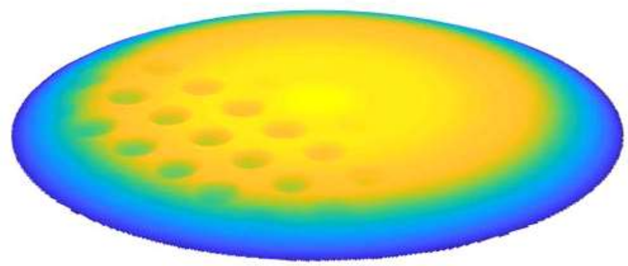

Fig.1 Zoom on the optimized textured surface of the pin. The texture elements consist of dimples (with prescribed circular area) whose depth distribution has been optimized in order to obtain the maximal load carrying capacity. In color is the gap height distribution.

CONCLUSION

The adjoint method can be successfully used in the field of tribology for the optimization of surface textures, allowing to fine-tune each single texture element individually rather than through a trial and error approach with dimples having all the same geometry. The effectiveness of the adjoint method will be also discussed using experimental support from pin-on-disc tribometer results and compared to textures obtained with traditional optimization processes.

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