INTERFERENCE EFFECT OF LARGE AND SMALL GROOVES ON THE REAL CONTACT AREA GROWTH OF ONE-DIMENSIONAL REGULAR WAVY SURFACE

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INTRODUCTION

Engineering surfaces machined by a face milling or by a lathe are characterized by an array of tool marks. It would be worth considering the contact of regular wavy surfaces. In particularly, in soft solids, such as rubber, the behavior up to the nearly full contact could play an important role in the technological functions such as sealing. The authors [1] have examined in previous study the elastic contact of various types of one-dimensional and two-dimensional regular wavy surfaces shaped in the simple profiles such as sinusoidal, spherical asperities or spherical valleys arranged periodically on the surfaces. However, in general, engineering surfaces never have simple profiles and are formed in overlapping wave of various size of irregularities.

The objective of this study is to elucidate how the superimposed smaller irregularities affect the dependence of the real contact area on the load. In this study, as the first stage, the real contact area growth of one-dimensional regular wavy surface having large and small grooves is investigated in the light of comparing the effect of the bulk thickness on each groove.

EXPERIMENTAL PROCEDURE

Three types of surface profiles A, B and C are formed on blocks of silicone rubber having a shape of quadrangular prism with a base 16 mm x 7 mm. Fig. 1 shows the surface profiles of specimens. In specimen A, large cylindorical groove with a width w_L of 2.67 mm and small cylindorical groove with a width w_S of 1.33 mm are aligned alternately. The depth of large groove h_L and small groove h_S are the same and are about 90 μm. In specimens B and C, small groove with w_S = 0.8 mm is inserted between the large grooves with w_L = 3.2 mm and h_L = 130 μm. h_S = 32 μm for specimen B and h_S = 64 μm for specimen C. In the case for specimen B, the aspect ratio h/w of the small groove is the same as that of the large groove. These surfaces of blocks are pressed into the bottom surface of a right angle prism in decompression environments.

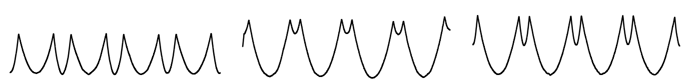
RESULTS AND DISCUSSION

Fig. 2 shows the variations of the observed contact images with increasing the mean pressure p. Here p is defined as the ratio of the normal load to the apparent contact area. When comparing specimens A and B for the thickness t of 10 mm, it becomes clear that in the case when the depths of both the large and the small grooves are the same, the large groove disappears first, then the contact images approach the complete contact. On the other hand, in the case when the aspect ratios are the same, the small groove disappears first. It was found from the real/apparent contact area versus mean pressure curve that when either the large or small groove disappears, the rate of increase in the real contact area shows sharp drop.

In the case for the specimen C, the large groove disappears first when the thickness of the specimen is larger than about 3 mm. On the other hand, when the thickness falls below about 1 mm, the small groove disappears first, because the decrease of the thickness make the extinction of large groove difficult which results in the increase of the contact pressure at the periphery of the small groove.

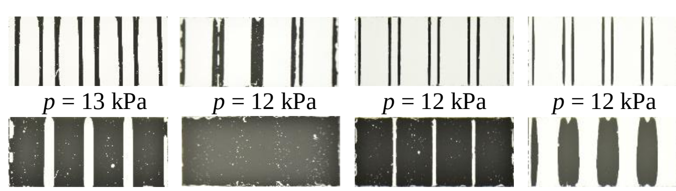
REFERENCE

[1] Matsuda, K., Mori, S., Hatanaka, A. and Nakamura, K., Tribol. Int., 124, 2018, 184-194.



(a) Specimen A (b) Specimen B (c) Specimen C

Fig. 1 Cross-sectional shape of specimens



(a) Specimen A (t = 10 mm) (b) Specimen B (t = 10 mm) (c) Specimen C (t = 10 mm) (d) Specimen C (t = 0.77 mm)

Fig. 2 Contact images of each specimen