A COMPARATIVE INVESTIGATION INTO

THE EFFECT OF SURFACE ROUGHNESS ON THE STATIC FRICTION

OF

STEEL SURFACES

THESIS

SUBMITTED AS PART OF THE REQUIREMENTS

FOR

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BY

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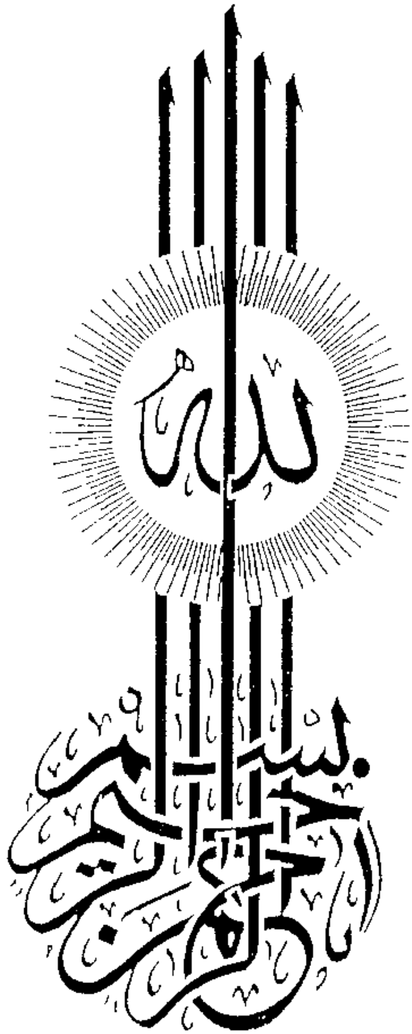
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S U M M U R Y

The object of this investigation was to find out the comparative effect of the various parameters of surface roughness on the static coefficient of friction of steel surfaces. The surfaces were prepared by various machining processes namely, shaping, milling, grinding, lapping and polishing. Wide ranges of surface roughness for each process were obtained through the variation of machining conditions.

Complete study of the geometry of the surface roughness was made with the aim of finding out the most significant parameters regarding the static coefficient of friction.

A special equipment was designed to assess the static coefficient of friction through measuring the critical angle of friction with a precise inclinometer.

The results were plotted in the form of relations between various surface roughness parameters and the static coefficient of friction, the results showed that the most significant parameters were the asperity angle (θ) and the specific process parameter. The specific process parameter is the product of the standard deviation

of peaks distribution (σ_p) and the smoothness index which is the ratio of depth of smoothness (G) and the centre-line-average (CLA) values.

A most fitting empirical relation, as well as a chart, was established.. the relation assumed the following form

$$\mu_s = 0.12 + \left[18\ \theta + 60 \log \left(\sigma_p \frac{G}{CLA} \right) \right] 10^{-4} + 0.8\epsilon$$

The relation included the effect of the mutual approach (ϵ) and the maximum scatter in the calculated values of the coefficient of friction was $\pm$ 5 % .

Besides and only for ground and polished surfaces relations could be established between the coefficient of friction and both centre-line-average and maximal depth values the empirical relations were as follows:-

for ground surfaces: $\mu_s = 0.116 + .012\ (CLA) + 0.8\epsilon$

$= 0.114 + 0.0033\ R_{max} + 0.8\epsilon$

for polished surfaces $\mu_s = 0.107 + .022\ (CLA) + 0.8\epsilon$

$= 0.106 + 0.0046\ R_{max} + 0.8\epsilon$

This result is of a great value in the assess of surface roughness of such surfaces through the measurment of its static frictional resistance.

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CONTENTS

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LIST OF TABLES

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LIST OF ILLUSTRATIONS

Page

INTRODUCTION

Although the problem of dry friction has occupied the minds of many previous investigators, yet only recently the nature and mechanism of dry contact could be adequately explained. J.A. Greenwood and J.B.P. Williamson stated that dry friction may be explained by the shapes of the peaks and their distribution through the upper decile of the texture. J. Halling, T.Tsukizoe, and T. Hisakado considered the plastic deformation of asperity junctions and the possibility of junction growth and derived theoretical formulae for the macroscopic coefficient of friction assuming pyramidal or conical asperties.

However no quantitative results were given for actual engineering surfaces. On account of the great importance of the dry friction assumes in many engineering situations, the need was felt for an experimental investigation of the relations between surface roughness and the static coefficient of friction.

Besides, the aim of designing a cheap and simple instrument utilizing any of such relations for the assessment of surface roughness was in view when planning the present work.

OBJECT AND SCOPE OF PRESENT WORK

OBJECT

This investigation has a double object:

(1) Finding out the most significant parameters of surface roughness which affect the static coefficient of friction for steel surfaces and establishing their appropriate empirical relations.

(2) Supplying adequate information for the design of a simple surface finish measuring instrument working on a functional basis for those surfaces which prove to have simple relations between their static frictional resistance and the usual standard parameters.

SCOPE OF WORK

The scope of work in this investigation covered the study of the comparative effect of the variation of the shape and standard deviation of the distribution of the peaks of surface roughness on the static coefficient of friction. The shape of the peaks was expressed in both the mean asperity angle and a 'smoothness index' in the form of the ratio between the smoothness depth of peaks (G) and the center-line-average value (CLA).