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Static Friction at High Contact Temperatures and Low Contact Pressure

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Abstract—The problem of measuring static friction at high temperatures and low contact pressures is theoretically analyzed, as well as the instruments for the accurate determination of the coefficient of static friction at high temperatures for contact pairs made of steel and bronze. The results of experimental investigation show that at low contact pressure and temperature above 120°C coefficient of static friction dramatically increases. This increase in the coefficient of friction can be of great practical value with regard to the load capacity of contacts where external forces are balanced with friction forces.

Keywords: coefficient of static friction, high temperatures, specific pressure, inclined plane, measuring instrumentation

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INTRODUCTION

Depending on the relative velocity of solid bodies in contact, one can discern between the friction of motionless objects and the friction of moving objects [1–4]. The friction that occurs when a body is motionless represents static friction. In order to move the body, one must apply external force to overcome static friction. Static friction grows with an increase in tangential displacement until it reaches a value required to produce the motion of bodies in contact, as shown in Fig. 1.

Although two bodies are motionless on a macroscopic level, there is a microdisplacement, also called "preliminary displacement," which occurs in the contact zone prior to the moving stage. This microdisplacement can reach relatively high values when one of the contact surfaces has small tangential stiffness compared to another contact surface, as is the case with rubber and metal. The principal parameter of static friction is the maximum static force; upon reaching this force, sliding occurs. Then, the friction force decreases and sliding proceeds uniformly.

The coefficient of static friction is determined using the maximum friction force, which must be overcome in order to produce the relative displacement of contact surfaces. The coefficient of friction depends on the normal load, atmosphere, temperature, adsorption films, material, and topography of solids in contact, etc. In general, it can be said that coefficient of static friction increases with an increase in surface roughness parameters [5], while a low coefficient of friction is related to the smooth surfaces [6]. Some authors concluded that certain friction parameters, e.g., skewness and kurtosis, exerted a greater influence on the coefficient of static friction than other parameters [7].

A better understanding of static friction requires knowledge of its generative mechanism, which was the topic of numerous investigations, especially in metal contact pairs [8, 9]. In particular, the authors of [8] studied static friction between a steel ball and an indium block, which concludes that the material starts

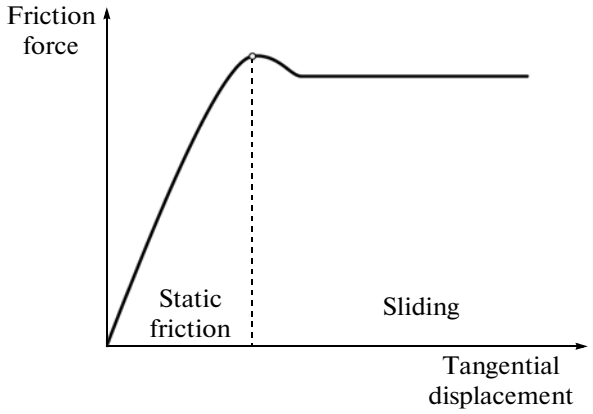

Fig. 1. Friction force vs. tangential displacement.