INFLUENCE OF SLIDING SPEED AND TEMPERATURE ON CONTACT PROPERTIES AND FRICTIONAL VIBRATIONS.

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Abstract The paper presents basic rheological models characterizing the behavior of materials in the contact zone. The growth of the FPC and the friction force depending on the time of the fixed contact explains the scheme.

Key words: sliding mode, material properties, friction, viscosities, loads.

The dependence of the friction coefficient on the sliding velocity V in the form of an exponential function suggested.

$$f = (a + bV)e^{-cv} + d \; .$$

Parameters a, c, c, d characterize the sliding mode and material properties of the friction pair. Parameter a depends on the physical properties of materials and roughness, c and c depend on viscosity and load, d depends on the design of the friction unit and the sliding mode. However, the effect of velocity on the contact properties with its small change is small in itself.

But a significant increase in speed leads to a significant increase in the contact temperature, as the friction power (F*V) is converted into heat. The increase in temperature, in turn, causes a noticeable change in the properties of the materials in the contact zone, the hardness decreases sharply. As the FOD increases, the intensity of molecular interaction decreases (τ_0, β), chemical transformations occur in the surface layers. At very high sliding velocities, surface melting is possible, and dry friction turns into hydrodynamic friction. In the general case, the friction coefficient decreases with increasing temperature.The theory of thermal processes occurring during friction is most fully developed in Russia by Professor A.V. Chichinadze and his scientific school. According to this theory, the maximum temperature at the contact spot can be represented as a sum:

$$T_{max} = T_0 + T_V + T_S + T_B,$$

Where T0 is the initial temperature of the friction pair, Tv is the average volumetric temperature of the pair element, TS is the average temperature at the nominal (contour) contact area, TB is the temperature flash at the contact spot. These factors are mediated by the thermal conductivity of the friction pair.

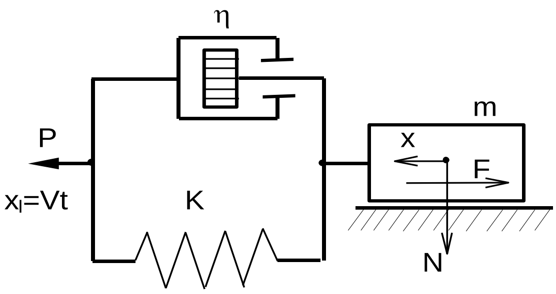

Fig. 1. Schematic of the model friction vibrations

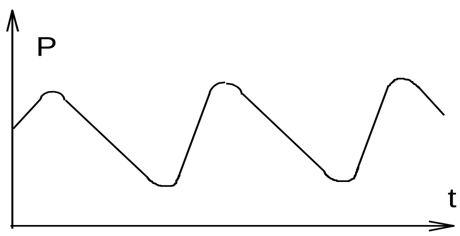

Fig. 2. Fluctuation graph tractive effort

The thermal conductivity problem is usually formulated in the following form: to find the temperature distribution in the elements of a friction pair, when a time and position-variable heat source acts on the contact, and heat is given to the environment from the free surfaces. In this case, the change in the thermophysical characteristics of materials depending on the temperature is taken into account.

The solution of the problem makes it possible to calculate TV, TS, TB under operating conditions of brakes, clutches and other friction units. Calculations and experiments have shown that Tmax can, even at relatively low speeds, reach hundreds of degrees, which leads to marked changes in the properties of materials in a thin surface layer.

During the operation of various mechanisms, there are often vibrations associated with friction. They lead to the appearance of squeaks, which appear when driving (squeaky wheels, brakes, squeaky car treads, when the car goes skidding, etc.). Such vibrations are called frictional vibrations. The causes of oscillations are the rheological properties of the contact, as well as the elastic properties of friction pair elements and their relationship with other parts. The main manifestation of contact rheology is the growth of FPC and, consequently, static friction force with increasing contact time and a jump-like drop in friction force during the transition from rest to motion, and then a drop in friction force with increasing sliding speed, caused mainly by a temperature jump on the contact spots. The dynamic model of such a system is shown in Fig. 1.

The model represents the Kelvin-Feugt and Saint-Venin bodies connected in series. If, for the sake of simplicity, we accept, what $\eta=0$, $\mu=\text{const}$, then Newton's 2nd law of motion of the ram will be written in the form:

$$m\ddot{x} = -k(x - Vt) + \mu N \operatorname{sign}\dot{x} = 0$$

The solution of this equation allows you to find the laws of motion of the ram and the oscillations of the tractive force. Fig. 1.18 shows an approximate graph of tractive force oscillations. The most detailed theoretical solutions in this area are made in Bauman Moscow State Technical University by F.R. Gekker and his students.

Depending on the damping level (system viscosity m), vibrations may or may not exist. The stability, reliability and durability of mechanical systems depend on this, which must be taken into account when designing mechanisms and replacing parts during repair and maintenance.

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