

NONLINEAR PHENOMENA FOR STICK-SLIP MOTION WHICH TAKE SHAPE LATENT PERIOD OF FRETTING-WEAR INTO NOMINAL-FIXED JOINTS

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Summary A physically based model of the static frictional interaction between dry surfaces is presented. The model of nominal fixed frictional contact (NFFC) at this loading by shear force in plane is based on principles of the theory microplastic deformation for frictional contact. The dependence of tangential properties NFFC from number of a cycle loading at fretting was investigated.

INTRODUCTION

Per the last years the tendency of a research small amplitude fretting is exhibited within the limits of 2...5 microns [1, 2] up to regime of preliminary displacement [3,4]. The loss of integrity of joints or modification of contact condition occur in three stages. Each stage has the duration and introduces the contribution to destruction of surface failure. In an initial moment of operation of joints probably elastic interaction of surfaces . At this slip is absent. As show researches, this stage practically will not be realized in real joints, as at any case there will be a plastic microdeformation of surfaces without a relative displacement. Because of various properties of materials contacting pair and difference geometry of contact the accumulation of plastic deformation happens unequally. Modification of contact properties lead to slip on boundary, that results to regime of partial slip . The distribution of slip area, i.e. zone of fretting-wear, to centre of contact sets in motion of gross sliding of surfaces .

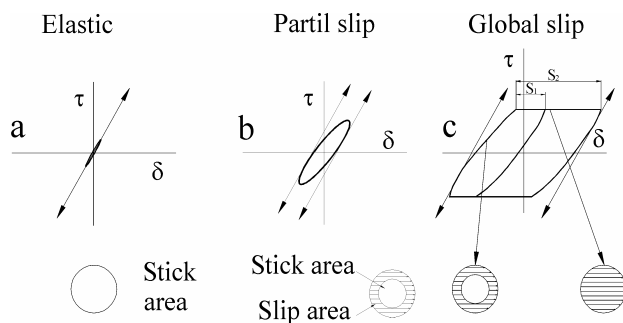


Fig.1 Behaviour of NFFC in dependence of contact loading

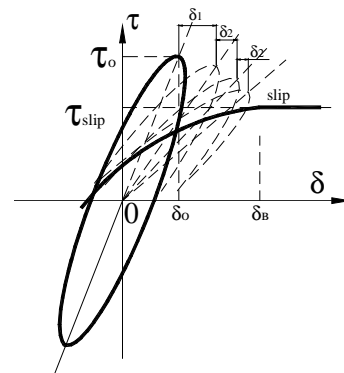


Fig. 2. The tendency of transition to gross slip of contact at tangential loading by a shear force.

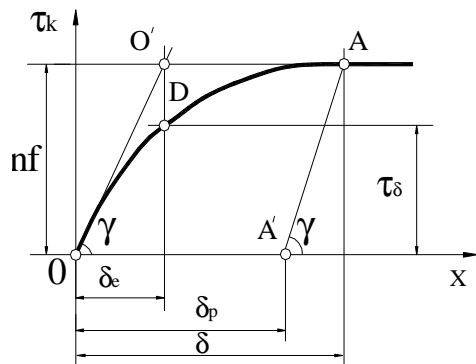
RESULTS

The purpose of work put deriving universal expression for the description of dependence of relative motion elements of nominally fixed contact at monoaxial tangential loading. In the basis of a solution of this problem the idea about « the third body» is fixed which places between contact surfaces [3]. This rheological model consists of a set parallel joint elements and takes into account main properties NFFC (elastic and frictional). And also property consisting in an advancing of growth of a strain on a comparison with growth of tangential stress in contact. The shear stress is considered as a results microscopic frictional displacement in various separately taken points of contact at a microscopic level contacting. Under microscopic frictional displacement will be imply also transitions of elements of contact, which occur for want $\tau_i > n_i \cdot f_i$ where n_i - microscopic normal pressure, f_i - microscopic coefficient of friction. The deformation is considered only in a direction of shear force and results of deformation as reached relatively transition X of elements contact for want of specific level of tangential stress

MAIN POSITIONS OF MATHEMATICAL AND EXPERIMENTAL MODEL

We received a main equation of curve of initial loading contact(1).According to Fig.3 we have the following performances of contact: δ_e -elastic component of a full preliminary displacement, $\delta_p = \delta - \delta_e$ plastic component of a preliminary displacement, $p = \delta_p/\delta_e$ parameter of plasticity, which is determined immediately from experiment. The mutual transition of contact elements is determined through an elastic part of a full preliminary displacement: $x = e \cdot d_e$, where e - relative current deformation.The researches were conducted under the scheme plane - full-sphere. The system of levers is selected thus that if the indication of the gauge makes 1 micron. Then the

mutual transition of elements of contact will make 0,025 microns. At the sensitivity of the inductive gauge 0,01 microns the exactitude of a measurement will be 0,00025 microns.



$$\begin{cases} t = nf \left[e - \frac{p}{(p+1)^p} \cdot e^{\frac{p+1}{p}} \right] & \text{at } 0 \leq e \leq p+1 \\ t = nf & \text{at } e \geq p+1, \end{cases} \quad (1)$$

Fig.3. Micro displacement of NFFC in dependence of shear stress

The experimental analysis by high accuracy at of symmetrical cycle loading shows, that the real hysteresis cycle have some difference from ideal. Loading alternately left and right levers have received, that already during one cycle the accumulation of micro plastic deformations take places. At the reaching of the certain amount of a cycle the relative deformation becomes boundary and will occur macrosliding of contact, i.e. beginning of fretting-process. It is important to mark, that the level of tangential stress in contact will drop even more not only because of microplastic reformation, but also because decrease of normal pressure if to consider work of actual joints(Fig.2).

The boundary significance cycle of latent period fretting will be equal:
$$N = \frac{d_b - d_0}{d_m} \quad (2)$$

It is clear, that the obtained picture is a result of transformation parameter of plasticity depending on an amount of a cycle, complicated structural and dislocation processes.

The stage of destruction of oscillating contact under following conditions is shown on Fig.4 for following conditions: $D_{\text{sphere}} = 12 \text{ mm}$, $n = 4 \text{ MPa}$, $t_{\text{max}} = 2,5 \text{ MPa}$, $N_{\text{max}} = 10^7$ cycles, $W = 30 \text{ Hz}$.

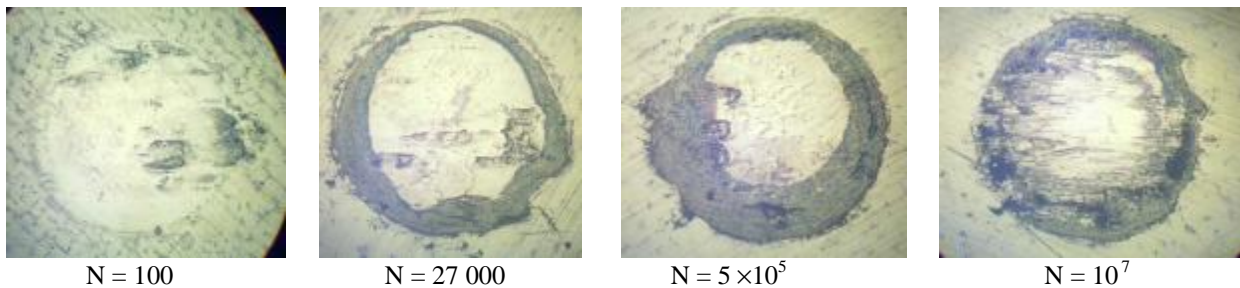


Fig.4 The pictures of destruction of contact zone for sphere to flat at oscillating loading

CONCLUSIONS

1. Because of mathematical modelling of preliminary displacement in nominally fixed frictional contact the point analytical dependence for curve «stress - deformation» is obtained, using which it is possible to investigate processes relating problems of friction rest as for constants as for cyclical loads. The obtained dependence can be applied to a mechanics of deformation solid body at of monoaxial shear loading.
2. The base criterion describing plastic properties NFFC is it the parameter of plasticity which represent the relation of a plastic (residual) part full preliminary displacement to it an elastic (returnable) part.
3. The experimental confirmation to analytical dependence and experimental data on the parameter of plasticity is obtained
4. Properties NFFC in an outcome of development fretting on an edge of contact zone was determined.
5. The falling of a shifting force at fretting makes 7 % from initial, parameter of plasticity is increased by 20 %.

References

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