Improved Theory of the Combined Dry Friction in Problems of Aviation Pneumatics' Dynamics

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ABSTRACT

It is proposed further development of the theory of multi-component dry friction [1, 2] which consists in presenting a more convenient form of the coupled friction models for the problems of the aviation pneumatics dynamics. The friction force and torque are computed by the integration over the contact area so that the exact dynamically coupled integral model accounting the relationship of all the components of friction is obtained. This exact model can be replaced by a new type of approximated models [2] which are the ratio of the linear form to square root of the quadratic form. These models permit to escape using not smooth functions in the cases when velocities are changed their signs and completely satisfy to the all integral model analytical properties as function kinematics parameters without increasing the number of coefficients.

Another improvement of the developed dry friction models consists in the accounting of the real distribution of the contact pressure. The known results including [3] were obtained only for the Hertzian pressure law. If the aviation tire model is considered, the first one can be used for the smallest contact areas and vertical forces [4], and the second one seems to be over simplified. The quasi-static contact pressure distribution for the real tire of diagonal structure was obtained using finite element simulation for several load cases. The numerical solution was interpolated by the Legendre polynomials, so that the obtained representation allows one to obtain the coefficients of the approximated dry friction models. The approximation coefficients of the proposed dry friction model are computed for the tire and the significant dependency of the dry friction spin on the pressure distribution is shown.

The constructed dry friction theory allows one not only the analytical solution of model problems but also can be applied in the engineering practice, for instance to predict the shimmy if the sliding and spinning cannot be neglected [3].

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