Nonlinear Dynamics of a Braking Pad and a Shaft Being in a Frictional Contact

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The simplified model of a frictional contact of a braking pad and a rotating shaft is analyzed. It is assumed that a coefficient of self-covering between pad and shaft is close to one. The shaft is subjected to rotation due to a given rotary moment. The braking pad is fixed to a base elastically (springs). For a given initial time the pad temperature is increased and due to thermal extension of the shaft both bodies begin to touch each other (a frictional contact appears). The friction forces lead to occurrence of heat transfer between two bodies. Assuming that the friction forces depend on a relative velocity between pad and shaft, the steady stick-slip as well as unsteady states are considered. From a mathematical point of view, the problem is reduced to that of simultaneous solution to the nonlinear differential equations governing dynamics of shaft and pad, and the equations of thermo-elasticity with the attached initial and nonlinear boundary conditions. Applying the integral Laplace transformation the problem is reduced to a set consisting of one integral Volterra equation and two nonlinear second order equations. It is observed that the considered system exhibits frictional regular and chaotic self-oscillations, when the heat transfer caused by friction does not occur. The critical parameters responsible for the occurrence of chaos have been estimated using the Melnikov's method. The numerical analysis has been carried out for the various parameters, and a special attention has been paid to analysis of the heat transfer influence on the dynamics of both bodies.

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