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ARGUMENTS FOR EQUIPIPPING ДТ-75M TRACTOR CARRIAGE WITH RECUPERATIVE ELEMENTS BY MEANS OF MATHEMATICAL SIMULATION

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By means of simulation dynamic model of a forest tillage machine the possibility of equipping ДТ-75 M tractor carriage with recuperative elements has been studied. In this case energy extraction in each carriage does not worsen vibration spectrum of tractor case up to 0,7 kW.

Decrease of energy losses in overcoming gravity and inertia at vertical and horizontal motion of forest tillage machines is one of the perspective and important trends in increase of their efficiency. The most appropriate way of decreasing these losses is recuperation into machine complex of that part of potential and kinetic energy, which is uselessly liberated into the environment at automatic idle motion of separate operating elements and machine in general. In this case movable parts of caterpillar undercarriage can be supplied with recuperative elements [1]. Recuperative element plays a part of a damper and decreases horizontal and vertical oscillations of tractor case in motion along forest roads with large quantity of obstacles and surface irregularity. To take into consideration of all features of the unit not isolated tractor but the complete unit with all equipment and disk has been studied (fig. 1).

Simulation model was designed according to the methodology [2]. The basis for the mathematical model is a set of 34 differential equations. To set up the equation system on the basis of the Lagrange equation of the 1-st type with undetermined multiplier the finite-element approach was used [3]. In this case the unit was considered as a complex of seven plane bodies connected with each other at some contact points in the form of joints, imponderable, non-stretched rods and springs. To integrate numerically the obtained system of differential equations the modified Euler method was used. Compu-

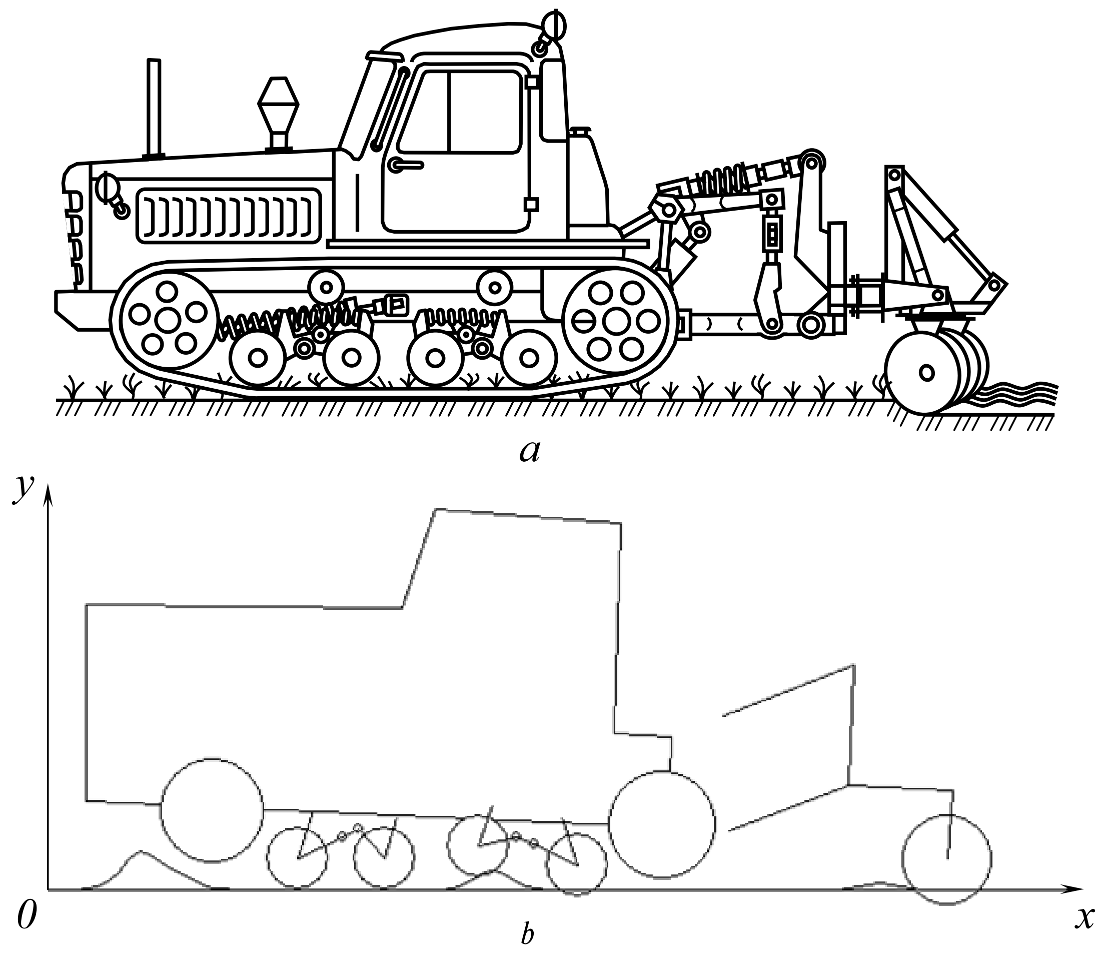

Fig. 1. *Tillage machine under study on the basis of ДТ-75 M tractor (a) and presentation of the machine in the model (b)*

ter experiments were carried out by means of specially designed programme in Borland Delphi 7 environment.

External agitations of the system were set up by the forces acting from the direction of soil and obstacles on carriage roll, drive and guide roll and on disk operating element. As in the model caterpillar was not considered, for generation of agitation function $q(x)$, i.e. surface geometry the algorithm permitting us to obtain smooth enough $q(x)$ was used. In particular, the function $q(x)$ was a superposition of the Gaussian peak with the parameters x_i (obstacle state), H_i (obstacle height) and σ_i (mean-square deviation setting up the width of obstacle).

The Gaussian peaks were distributed along the length of the controlled region by chance according to the uniform law. In this case the parameters H_i and σ_i were also chosen by chance according to the uniform law from the intervals: [0; 0,1 m] for H_i and [0,05 m; 0,15 m] for σ_i. The results presented in the given paper corresponds to linear density of obstacles 1000 pieces/km and velocity of the machine motion 2 m/s. Calculating the forced acting on the machine bodies from the direction of the surface the common viscoelastic soil model was used [4].

The recuperative elements suggested should be in tractor carriages and operate simultaneously with serial

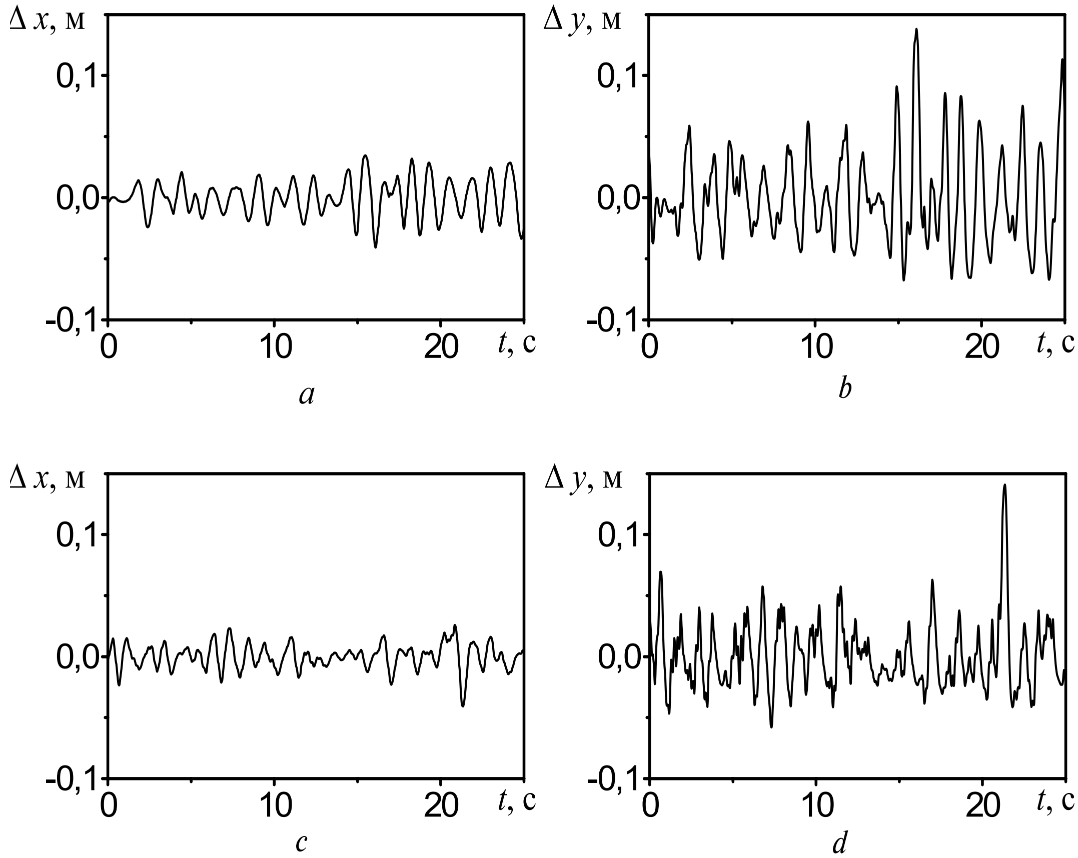

Fig. 2. *Horizontal (a, c) and vertical (b, d) deviations of tractor case ДТ-75 M at the damping coefficient values θ_1=300 H·s/m (a, b) and θ_2=8000 H·s/m (c, d)*

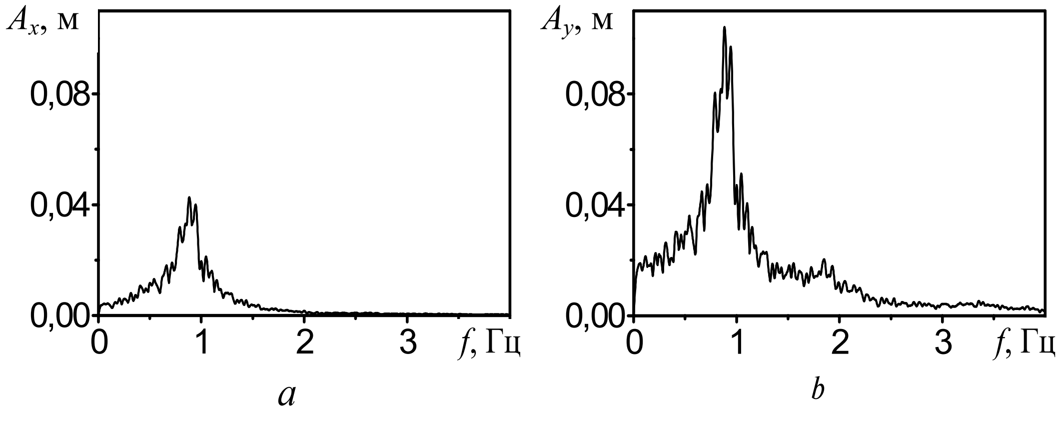

Fig. 3. *Amplitude-frequency plot of horizontal (a) and vertical (b) deviations of tractor ДТ-75 M case at the value of the damping coefficient θ_1=300 H·s/m*

carriage springs. Therefore, in the model the recuperative element is presented in the form of additional damper of serial shock-absorber. The main goal of computer investigation was to study the influence of the damping coefficient of the recuperative element θ on amplitude-frequency plot (AFP) of tractor case oscillations. For this purpose computer experiments with two different values of damping coefficient were carried out: θ_1=300 N·s/м (damping coefficient of serial shock-absorber) and θ_2=8000 N·s/m (damping coefficient close to maximum possible one, at which elastic reaction of the carriage to surface irregularity ceases).

To achieve relevant statistic quality in the process of computer experiment the unit moved for the length of 1000 m. In this case the relative horizontal $\Delta x(t)$ and vertical $\Delta y(t)$ point deviations of tractor location were registered (fig. 2). Corresponding AFP $A_x(f)$ and $A_y(f)$ (fig. 3) were obtained by means of the Fourier function transformations $\Delta x(t)$ and $\Delta y(t)$.

It was stated that at larger damping the deviation amplitude $\Delta x(t)$ and $\Delta y(t)$ decreases (fig. 2). Analysis of AFP showed that at different damping coefficients the form of, $A_x(f)$ and $A_y(f)$ functions does not qualitatively change, however, when increasing the coefficient of damping the functions decrease in absolute value.

The model allowed us to calculate power dispersed in dampers θ in the process of the unit motion. Using recuperative elements instead of dampers the given power can be sent back into energetic system of tractor. At θ_1=300 N·s/m the power dispersed by one damper amounts nearly 0,18 kW, at θ_2=8000 N·s/m it is about 0,70 kW. Thus, at usage of the recuperative element with sufficient damping effect the power returned from four carriages of tractor amounts about 2,8 kW (i. e. about 4 h.p.).

In future, the developed simulation model allows the study of equipping other parts of the unit with recuperative elements: attached implements of tractor and safeguard of tillage tools.

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