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STABILITY OF MOVEMENT OF A SMALL ROOTING MACHINE AGGREGATED WITH THE MOTOBLOCK

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Abstract

Small agricultural machines integrated with the moto block often deviate from the intended direction during operation, depending on the operating conditions due to which the movement of the unit becomes unstable, the characteristics of the machine change, the tillage technology is disturbed, the machine becomes difficult to control and the productivity decreases.

The article is based on theoretical research that makes it possible to determine a moto block depending on the speed limit ($\boldsymbol{V}$) of the aggregate agricultural machine mass-geometric and mechanical parameters according to which the exact nominal stability of the movement of the unit is defined.

Key word: moto block, car, unit, limit, speed, stability.

Introduction

At present, in the agricultural production of the Republic of Armenia, motoblocks are widely used for cultivating small plots of land and small agricultural cars,that are used effectively in the processing of slopes. Therefore, the problem arises to ensure the stable and safe operation of these machines with high operating rates.

Theoretical studies were obtained from the calculation that allows you to determine a tillerblock with an aggregated village. The maximum speed of the car ($V_{\text{гр}}$) depends on the mass-geometric and mechanical parameters, according to which the exact nominal stability of the movement of the unit is defined**.**

In this regard, the movement of the unit becomes unstable, the characteristics of the movement of the machine deteriorate: longitudinal, transverse and stability of the stroke, the technology of land cultivation is disrupted, machine control becomes difficult and labor productivity decreases [1,2].

For a car aggregated with a tillerblock, its lateral fluctuations are more dangerous from a dynamic point of view especially when working on slopes.

In order to ensure the stability of the car's movement, we will study the problem by following techniques [1,3,5]:

- a rigid one is attached to the tillerblock, there are no gaps,
- there are no lateral oscillations in the vertical plane,
- the movement of the attachment point of the machine with the tillerblock is assumed to be rectilinear,

- elastic properties of the soil are not taken into account.

Let's imagine a small-sized machine aggregated with a tillerblock as a mechanical volatile system, the design scheme of which is shown in Fig.1. The village machine oscillates with respect to the longitudinal axis of the unit around the point C. The initial deviation of the longitudinal axis from the specified direction of movement is α angle.

Let's denote the transverse and longitudinal components of the force affecting the coupling point, respectively P_{kpx} and P_{kpy},, the force of resistance to the movement of the machine Rcx:

The center of gravity of the car (O_M) performs a complex movement with a speed and a ratio of $\overline{V}$, due to the vibrations of the car, α-angular velocity [1,2,3,4,6].

The speed of movement in accordance with the center of gravity (O_M) of the car is determined by the following expression:

$$\overline{V_0} = l \cdot \alpha: \tag{1}$$

The velocity of the point O_M is equal to: ` $\overline{V_M}=\overline{V}+\overline{V_0}$, with the longitudinal axis forms an angle $\Psi = \alpha + \alpha_0$.

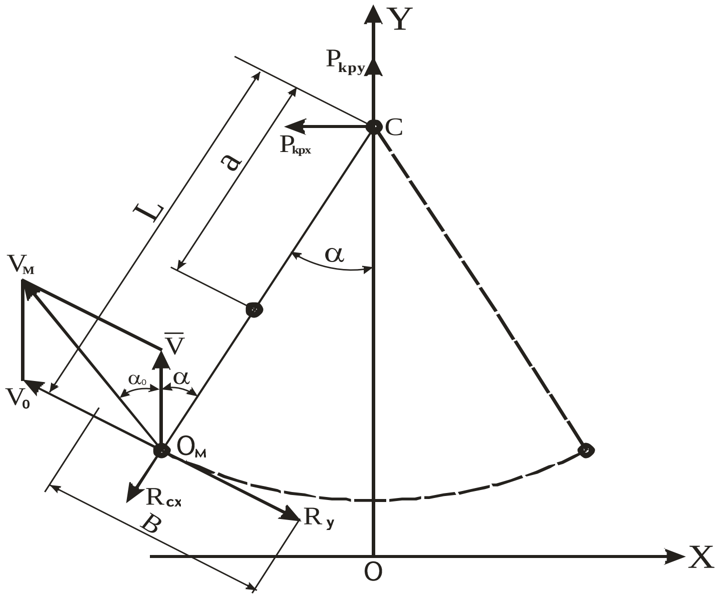

Fig. 1 Fluctuation calculation scheme of the tillage car around the connection point C

Considering that α and α_0 angles are small, we can recognize that $\alpha_0 = \frac{\overline{V_0}}{\overline{V}}$ and $\Psi = \frac{\overline{V_0}}{\overline{V}} + \alpha$, or taking into account (1) we can write:

$$\Psi = \frac{l\alpha}{V} + \alpha:$$

The force of the transverse resistance of the Earth on the machine can be determined in the following expression:

$$R_y = R_{y\dot{\alpha}} + R_{y\alpha} = \frac{K_y l \dot{\alpha}}{V} + K_y \cdot \alpha \tag{2}$$

where -K_y is the coefficient of coupling resistance of the machine. We give the force R_y to counteract the Earth with the following amounts

$$R_y = R_{y\dot{\alpha}} + R_{y\alpha}$$

$R_{y\alpha}$ - is identified with the elastic restoring force at the free oscillation of the mass on the spring and is determined by the following formula: $R_{y\alpha} = K_y \cdot \alpha$:

Here K_y is the coefficient of coupling resistance, similar to the coefficient of spring stiffness, and α is the linear displacement of the mass.

$R_{y\dot{\alpha}}$ the total is directed against the velocity $\overline{V}$ and is determined by the following expression`

$$R_{y\dot{\alpha}} = \frac{K_y l \dot{\alpha}}{V}:$$

Let 's make an expression from the center of gravity of the movement to point C.

$$(I_Z + m \cdot a^2) \cdot a = -R_y \cdot l, \tag{3}$$

where I_Z is the moment of inertia of the machine with respect to the center of gravity (O_M), $(I_Z + ma^2)$ is the moment of inertia with respect to the point C.

Putting the value of R_y in (3) we get:

$$(I_Z + ma^2) \cdot a = -\left(\frac{K_y l a}{V} + K_y \alpha\right) \cdot l,$$

or

$$\alpha + \frac{K_y l^2}{V(I_Z+ma^2)} \cdot a + \frac{K_y l}{I_Z+ma^2} \cdot a = 0 \tag{4}$$

The last equation (4) has the character of an oscillatory motion, which depends on the ratio of the characteristic coefficients of the equation

$$K^2 + \frac{K_y l^2}{V(I_Z+ma^2)} \cdot K + \frac{K_y l}{I_Z+ma^2} = 0 \tag{5}$$

The roots of the characteristic equation will be

$$K_{1,2} = -\frac{K_y \cdot l^2}{2V(I_Z+ma^2)} \pm \sqrt{\frac{K_y^2 \cdot l^4}{4V^2(I_Z+ma^2)} - \frac{K_y l}{I_Z+ma^2}} \tag{6}$$

If $|K|$coefficient is equal to zero, then the machine will make harmonious vibrations in accordance with the following law

$$\alpha_t = \text{A} \cdot \sin(\beta \cdot t + \alpha_0).$$

This is possible in cases where either $K_y = 0$, or $V = \infty$

Consider the following three typical motion events

$$K_1 = K_2 = -\frac{K_y \cdot l^2}{2V(I_Z+ma^2)},$$

$$V = \frac{L}{2}\sqrt{\frac{K_y l}{(I_Z+ma^2)}}: \tag{7}$$

Hence (4) the solution of the equation will be:

$$\alpha_t = (C_1 + C_2) exp\left[-\frac{t}{2} \cdot \frac{K_y \cdot l^2}{V(I_Z + ma^2)}\right] \tag{8}$$

According to the last expression of any initial conditions, $t \to \infty$, $\alpha_t \to 0$

Subsequently, the off-balance village car will return to its original position at any value of the initial deviation angle α.

The roots of the typical equation K_1 և K_2 are negative real numbers not equal to each other. In this case (4) the general solution of equation will be

$$\alpha_t = C_1 exp K_1 t + C_2 exp K_2 t \tag{9}$$

Therefore, $t \to \infty$, $\alpha_t \to 0$, when the oscillations are extinguished and the village machine that has left the equilibrium state returns to its original position, then faster than in the previous case, since $(C_1 + C_2 t)$ the manufacturer slows down the movement. The characteristic roots of the equation are complex numbers

$$K_1 = u + iv, \quad K_2 = u - iv, \quad \text{where` } u = -\frac{K_y L^2}{2V(I_Z + ma^2)}, \quad \text{v} = \sqrt{\frac{K_y L}{I_Z + ma^2} - \frac{K_y^2 L^4}{4V^2 (I_Z + ma^2)^2}}$$

Therefore (4) the general solution of the equation will have the following form

$$\alpha_{t=} exp(C_1 \cos ut + C_2 \sin vt),$$

or

$$\alpha_t = A exp\, ut(vt + \alpha_0), \ when\ (t = 0,\ \alpha = \alpha_0)$$

Since $u < 0$, the amplitude of the oscillations $A \cdot exp$ ut when t → ∞ tends to zero, and the oscillations will be extinguished.

Thus, a tillerblock with aggregation of each village. the movement of the machine at a certain speed after reaching, depending on the initial deviation of the anchor, can receive floating fluctuations, which are characterized in accordance with the maximum repayment rate.

$$V_{\text{гр}} \leq 0{,}5L\sqrt{\frac{K_y L}{(I_Z + ma^2)}} \tag{10}$$

It is necessary to strive to ensure that the tillerblock is aggregated with the tillage and the estimated speed of the machine will be higher than the maximum permitted speed corresponding to its operating conditions.

Results and analysis

Analysis of the expression obtained (10) shows that an increase in the speed limit contributes to an increase in the length of the clutch (L) and the coefficient K_y, as well as a decrease in the inertia of the agricultural machine, therefore, it is necessary to strive for the center of gravity of the agricultural machine as close as possible to the attachment point.

A tillerblock with an aggregated agricultural machine to assess the influence of mass-geometric parameters on the limiting speed of the machine, graphical suspensions are constructed` $V_{\text{гр}} = F(I, m, a, K_y)\ (Fig. 2)$.

During the calculations, the average values of the tested parameters were selected as the average values

The analysis of graphical dependencies shows that a tillerblock with an aggregated agricultural machine the maximum speed of the car is most intensively affected by the distance between the center of gravity and the trailer of the agricultural machine. This distance is from 0.2 to 0.7 m, it is possible to increase the speed limit by more than six times, up to 3.2 km / h. The coefficient of clutch resistance of the agricultural machine K_y also significantly affects the cost of the speed limit. When the K_y value is doubled, the speed limit will increase from 1.24 km/h to 1.9.7 km/h.

Analyzing the obtained data, it turns out that the parameters of the oscillating motion of the village car are less sensitive to the change of its mass. The increase in the weight of the agricultural machine leads to a decrease in the limit speed of the unit in a small range, in particular from 1.67 km / h to 1.33 km/h.

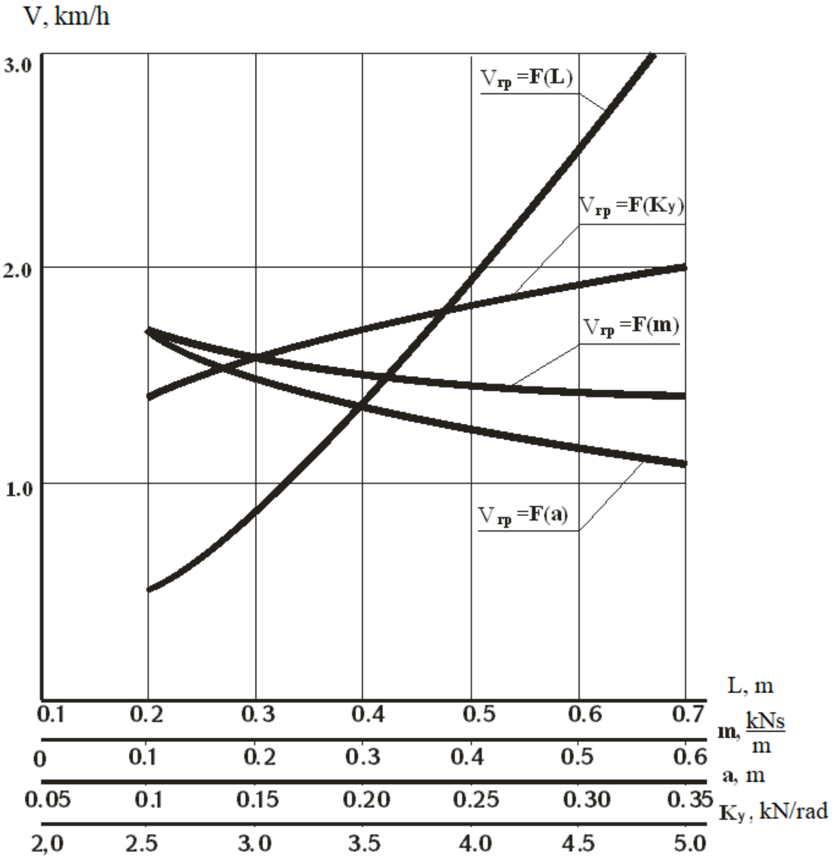

Fig. 2 A tillerblock with an aggregated agricultural machine, the dependence of the maximum speed of the car on its mass-geometric and mechanical parameters

The distance from the point of attachment of the agricultural machine also has a certain effect on the value of the speed limit. Its extension from 0.1 m to 0.35 m leads to a reduction of the limit speed from 1.6 km / h to 1.05 km/h.

Conclusion

1. A small agricultural machines aggregated with a tillerblock often deviate from a given direction during operation, which causes the movement of the unit to become unstable, the quality of the movement of the machine deteriorates, the technology of tillage is disrupted, it is difficult to control the machine and labor productivity decreases,

2. A tillerblock aggregated with an agricultural machines, using the formula for determining the maximum speed of the car ($V_{\text{гр}}$) (10), makes possible more accurately assess the stability of the movement of the unit,
3. The theory of the resulting calculation allows us to obtain the best condition for the stability of the direction of the machine in accordance with these operating conditions by adjusting the structural and kinematic parameters of this mechanical system.

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ՄՈՏՈԲԼՈԿԻ ՀԵՏ ԱԳՐԵԳԱՏԱՎՈՐՎԱԾ ՓՈՔՐՔՉԱՓ ԱՐՄԱՏԱՊՏՂԱՀԱՆ ՄԵՔԵՆԱՅԻ ՇԱՐԺՄԱՆ ԿԱՅՈՒՆՈՒԹՅՈՒՆԸ

Ա.Պ. Տոնապետյան
Հայաստանի ազգային ագրարային համալսարան

Մոտոբլոկի հետ ագրեգատավորված փոքրքչափ գյուղատնտեսական մեքենաները աշխատանքի ժամանակ, շահագործական պայմաններից կախված, հաճախ շեղվում են առաջադրված ուղղությունից, որով պայմանավորված ագրեգատի շարժումը դառնում է անկայուն, վատանում է մեքենայի շարժման հատկանիշները, խախտվում հողի մշակման տեխնոլոգիան, դժվարանում է մեքենայի կառավարումը, նվազում աշխատանքի արտադրողականությունը:

Հոդվածում տեսական հետազոտություններով ստացվել է հաշվարկի տեսություն, որը հնարավորություն է տալիս որոշելու մոտոբլոկի հետ ագրեգատավորված գյուղ. մեքենայի սահմանային արագությունը ($V_{гр}$) կախված զանգվածա-երկրաչափական և մեխանիկական պարամետրերից, որով և առավել ճշգրիտ գնահատել ագրեգատի շարժման կայունությունը:

Բանալի բառեր. մոտոբլոկ, մեքենա, ագրեգատ, սահմանային, արագություն, կայունություն:

УСТОЙЧИВОСТЬ ДВИЖЕНИЯ АГРЕГАТИРУЕМОЙ С МОТОБЛОКОМ МАЛОГАБАРИТНОЙ КОРЧЕВАЛЬНОЙ МАШИНЫ

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Малогабаритные сельскохозяйственные машины, агрегатируемые с мотоблоком, во время работы, в зависимости от условий эксплуатации, часто отклоняются от заданного направления, в связи с чем движение агрегата становится неустойчивым, ухудшается качество движения машины, нарушается технология обработки почвы, затрудняется управление машиной, снижается производительность труда.

В статье представлена теория расчета, основанная на теоретических исследованиях, позволяющая определить предельную скорость сельскохозяйственной машины, агрегатируемой с мотоблоком $(\boldsymbol{V}_{\text{гр}})$ в зависимости от массо-геометрических и механических параметров, с помощью которых можно более точно оценить устойчивость движения агрегата.

Ключевые слова: мотоблок, машина, агрегат, предельная скорость, устойчивость.

- *Հետազոտությունն իրականացվել է ՀՀ գիտության կոմիտեի ֆինանսական աջակցությամբ՝* 21T-4B008 *ծածկագրով գիտական թեմայի շրջանակներում:*
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