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Research of the Movement of the Combination Machine Straightener in the Longitudinal-Vertical Plane

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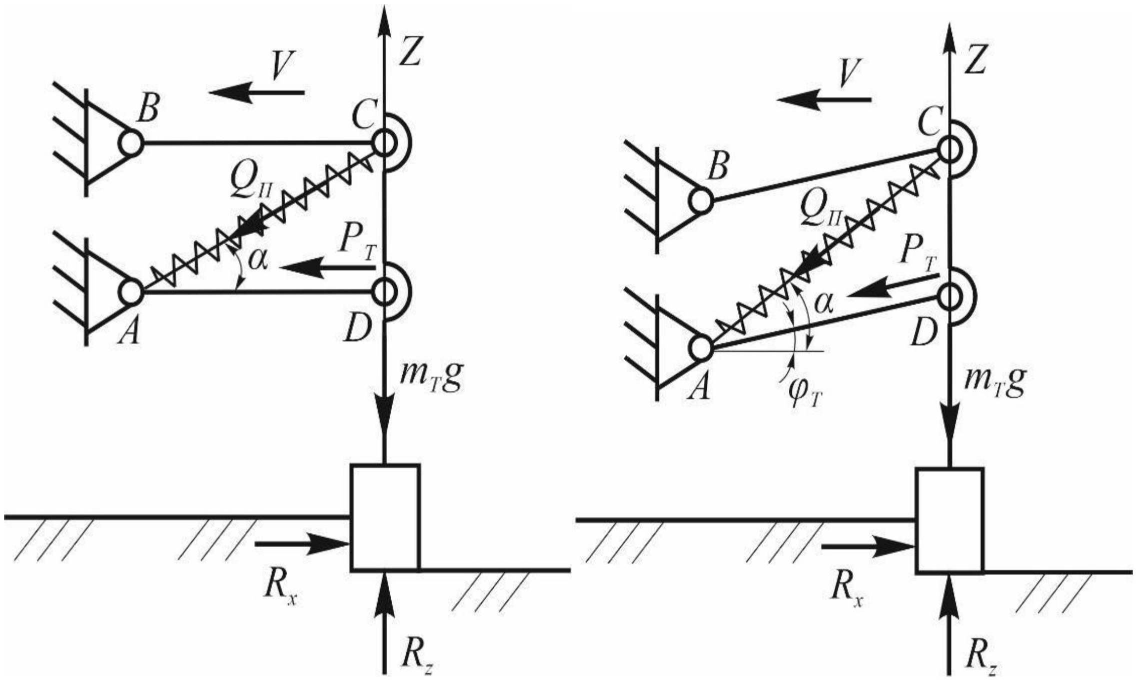
Abstract: The article presents the results of the experimental studies conducted to study the influence of the opening angle of the soil pusher of the combined machine leveler used in the preparation of land for planting on the performance indicators of the leveler.

Keywords: Combined, machine, leveler, parallelogram, mechanism, soil, pusher, compression, traction, resistance.

Republic of Uzbekistan This article presents the results of studies on ensuring smooth movement of the combined machine leveler used in the preparation of land for sowing seeds in the longitudinal-vertical plane [1]. The leveler of the combined machine consists of plates attached to each other at a certain angle, which smooth the unevenness formed on the field surface by the softener and bullet-like claws of the machine. In this case, the leveler smoothes the bumps formed between the softener and the bullet-shaped claws by pushing them to the edges formed in their tracks. The leveler of the combined machine is connected to its frame by means of a parallelogram mechanism equipped with a compression spring. Since the physical and mechanical properties of the soil are variable, the R_x and R_z forces acting on the leveler during the operation of the combined machine (see the picture) are constantly changing during the operation. For this reason, during the operation of the machine, the leveler is not only in forward motion, but also in a vertical direction, that is, along the Z axis, it is also in a forced oscillating motion, which causes a change in its impact on the soil. This has a negative effect on the leveling of the field surface. It is self-evident that the amplitude of vertical forced vibrations of the leveler should be as small as possible so that the surface of the field is leveled at the same level along the entire length. To achieve this, a differential equation representing vertical forced vibrations of the leveler was created according to the calculation schemes presented in the figure. It has the following final appearance

$$m_T\ddot{Z} + Bb_T\dot{Z} + \left(BC_T + C_n \frac{d}{\sqrt{l^2+d^2}}\right)Z = \Delta R_x(t)tg\varphi_T + \Delta R_z(t), \qquad (1)$$

in this m_T – the mass of the leveler, kg; V – coverage width of the leveler, m; V_T – coefficient of adhesion of the soil per unit coverage width of the screed; S_T – coefficient of compaction of the soil per unit coverage width of the leveler; l – the length of the longitudinal pull of the parallelogram mechanism, m; d – vertical distance between the hinges of the parallelogram mechanism, m; ΔR_x (t), ΔR_z (t) –R_x and R_z variable constituents of forces (moving forces); φ_T – angle of deviation of parallelogram mechanism pulls from horizontal position, degrees.



a) b)

a, b are balanced and out-of-balance states of the leveler, respectively

Scheme for studying the movement of the leveler in the longitudinal-vertical plane

ΔR_x (t) and ΔR_z (t) if we assume that the forces change according to the harmonic law, the solution of the equation (1) representing vertical forced vibrations of the straightener and its amplitude will have the following forms [2]

$$Z(t)=\frac{1}{m_T}\sum_{n=1}^{n_1}\frac{(\Delta R_x tg\varphi_T+\Delta R_z^{y})\cos(n\omega t-\delta_n)}{\sqrt{\left[\dfrac{BC_T\sqrt{l^2+d^2}+C_n d}{m_T\sqrt{l^2+d^2}}-(n\omega)^2\right]^2+\left(\dfrac{Bb_T}{m_T}\right)^2(n\omega)^2}} \tag{2}$$

and

$$A_T=\frac{1}{m_T}\sum_{n=1}^{n_1}\frac{(\Delta R_x tg\varphi_T+\Delta R_z^{y})}{\sqrt{\left[\dfrac{BC_T\sqrt{l^2+d^2}+C_n d}{m_T\sqrt{l^2+d^2}}-(n\omega)^2\right]^2+\left(\dfrac{Bb_T}{m_T}\right)^2(n\omega)^2}}, \tag{3}$$

in this n = 1,2,…, n_1 – number of harmonics; ω – frequency of rotation of variable members, c^{-1};

$$\delta_n=arctg\frac{k_T b_T(n\omega)\sqrt{l_{бm}^2+d^2}}{\left(k_T C_T+C_n\dfrac{d}{\sqrt{l_{бm}^2+d^2}}\right)-m_T\sqrt{l_{бm}^2+d^2}(n\omega)^2}. \tag{4}$$

(According to expressions 2) and (3), the same level of influence of the leveler on the field surface can be achieved mainly by the correct selection of the parallelogram mechanism's pressure spring and the angle of deviation of the pullers relative to the horizon. If it is ensured that the longitudinal pullers of the parallelogram mechanism occupy a horizontal position during the work process, ΔR_x (t) variable force and, therefore, changes in the physical and mechanical properties of the soil and the speed of aggregate movement do not affect the performance of the leveler, and as a result, optimal conditions are created for leveling the field surface at the same level.

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