Determination of the Extension Strength of the Press Spring of the Parallelogram Mechanism of the Combined Disc Harrow

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ABSTRACT

The article presents the results of theoretical studies to determine the tension force of the compression spring of the parallelogram mechanism of the combined disk harrow of the leveler-compacter. In the course of the research, analytical expressions were obtained to determine the tension force of the pressure spring, on the basis of which it was determined that the tension force of the pressure spring of the parallelogram mechanism should be 452 N in order for the planer-compacter teeth to sink into the soil to a given depth.

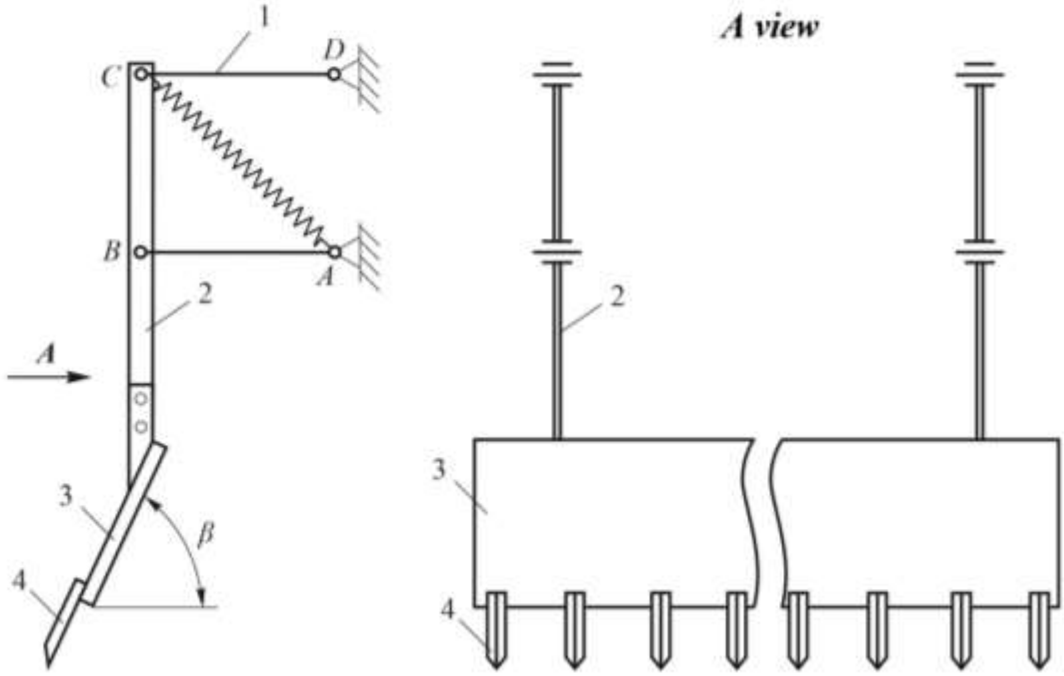
Keywords: combined disc harrow, planer-planner, parallelogram mechanism, pressure spring, tension force of the pressure spring, planner teeth, physical and mechanical properties of the soil.

Introduction. Currently, in Uzbekistan, disc harrows are widely used in the preparation of land for sowing wheat and re-sowing, as well as in the pre-sowing cultivation of loose lands. But in this case, additional processing is carried out with a leveler and toothed harrows to prepare the soil for sowing. This leads to an increase in the cost of tillage, including fuel consumption.

On the basis of what was stated in the Research Institute of Agricultural Mechanization, a suspended combined disc harrow was developed, which is used in preparing land for sowing wheat and re-sowing, as well as in pre-sowing cultivation of loose lands, and studies were carried out to substantiate its parameters [1-8].

The developed combined disc harrow consists of a common frame equipped with a suspension device and two rows of spherical disc-shaped working bodies (disk softeners), a planer-compactor and a lamellar roller. During operation, the disc softeners located in the first row cut, crush and mix the soil and plant residues and push them to one side, while the disc softeners in the second row perform the same process and push the soil to the other side. As a result, plant residues and soil are finely crushed and a soft layer is formed. The planer and roller additionally grind, level and compact the surface of the layer treated with disk plasticizers [3-8].

Materials and methods. The planer compactor of the combined disc harrow consists of a leveler and teeth attached to it and is mounted on its frame using parallelogram mechanisms equipped with pressure springs (Figure 1).



1-parallelogram mechanism with pressure spring; 2-nd column; 3-level; 4-th tooth
Figure 1. Scheme of the combined disc harrow planner-compacter

In the article, a theoretical study was carried out to determine the tension force of the pressure spring of the parallelogram mechanism of the combined disk harrow of the planner-compacter using the basic rules and methods of theoretical and agricultural mechanics.

Results and discussion. Let us determine the tension force of the pressure spring of the parallelogram mechanism of the rectifier-compressor using the calculation schemes presented in Fig. 2. First, consider the forces acting on the planer-compacter during operation. The following forces act on it (Figure 2, a):

$G = mg$ – Gravity of the glider-compacter (where m is the mass of the glider-compacter, kg; g is the gravitational acceleration, m/s^2), N;

$Q_{nб}$, Q_{nm} – longitudinal and vertical components of the tension force of the pressure spring of the parallelogram mechanism of the equalizer-compressor, N;

$R_{1б}$, R_{1m} – longitudinal and vertical components of the resultant reaction force acting on the planner-compacter planner from the ground, N;

$R_{2б}$, R_{2m} – Longitudinal and vertical components of the resultant reaction force acting on the teeth of the equalizer-seal, N.

Let us bring all the acting forces to the movable hinge V of the parallelogram mechanism of the equalizer-compressor [9] (Figure 2, b) and compose the equation for their balance relative to the fixed hinge A

$$\sum M_A = \left(mg + n_n Q_{nm} - R_{1m} - R_{2m}\right) l = 0 \quad (1)$$

and

$$mg + n_n Q_{nm} - R_{1m} - R_{2m} = 0, \quad (2)$$

where l is the length of the longitudinal rods of the parallelogram mechanism, m; n_n – number of springs installed on the equalizer-compressor, pcs.

(2) определяем Q_{nm} из выражения

$$Q_{nm} = \left(R_{1m} + R_{2m} - mg \right) / n_n. \quad (3)$$

From figure 2

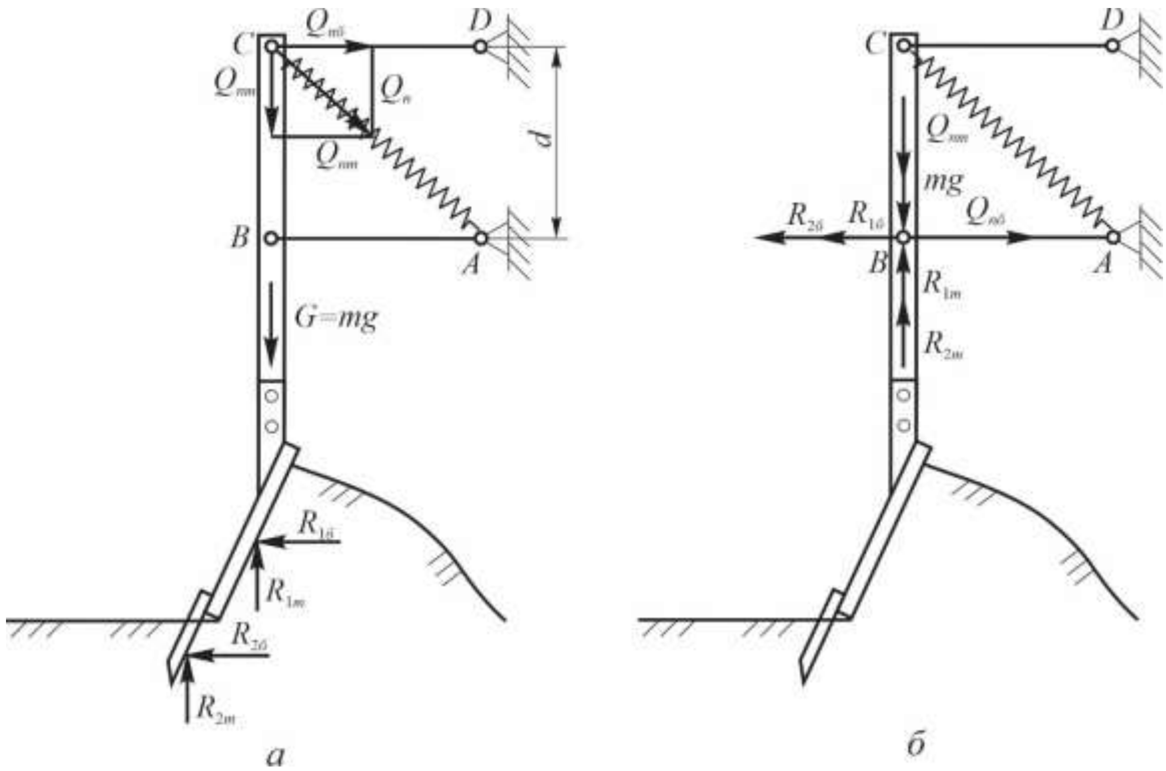


Figure 2. Scheme for determining the tension force of the pressure spring of the parallelogram mechanism of the rectifier-compressor

$$Q_{nm} = Q_n \frac{d}{\sqrt{l^2 + d^2}} \quad (4)$$

and solving it with respect to Q_n, we get the following

$$Q_n = \frac{Q_{nm}\sqrt{l^2 + d^2}}{d}, \quad (5)$$

where d — rasstoyanie po verticali mejdu nepodvijnymi sharnirami parallelogrammnogo mechanism, m.

By substituting the value of Q_{nm} into the above expression (3), we get the following result

$$Q_n = \left(R_{1m} + R_{2m} - mg \right) \frac{\sqrt{l^2 + d^2}}{n_n d}. \quad (6)$$

R_{1m}, R_{2m} We express them through the parameters of the aligner and teeth, as well as the physical and mechanical properties of the soil. [10, 11]:

$$R_{1m} = \frac{2f^{'}}{\pi}\rho_0 gBZ_{н}l_{н}ctg\beta \tag{9}$$

and

$$R_{2m} = n_n q_m = \left(\frac{B}{a}+1\right)Q_t, \tag{10}$$

here f' is the soil-to-soil friction coefficient;

ρ_0 – compacted soil density in front of the planer-compacter, kg/m^3;

B – width of the leveler-compactor, m.

$Z_н$, $l_н$ – height and length of longitudinal irregularities formed on the field surface under the influence of disk softeners, m;

β – installation angle of the equalizer-compacter relative to the horizon, °;

a – transverse distance between teeth of compact aligners, m;

Q_t – vertical load on each tooth, ensuring its immersion to a given depth, N;

Substituting the values of R_{1m} and R_{2m} according to expressions (7) and (8) into (6), we obtain the following

$$Q_n = \left[\frac{2f^{'}}{\pi}\rho_0 gBZ_{н}l_{н}ctg\beta + \left(\frac{B}{a}+1\right)Q_t - mg\right]\times\frac{\sqrt{l^2+d^2}}{n_n d}. \tag{11}$$

f'=0,5, ρ_0 =1100 kg/m^3, B=3,0 m, $Z_н$=0,10 m, $l_н$=0,50 m, β=60º, a=0,1 m, Q_t=16 N, m=50 kg, l=0,45 m, d=0,16 m, n_n=2 accepted, calculations according to the expression (11) showed that the tension force of each parallelogram mechanism pressure spring of the leveler-compacter should be 452 N.

Conclusion. In order for the teeth of the combined disc harrow of the equalizer-compactor to be immersed in the soil to a predetermined depth, the tension force of the pressure spring of its parallelogram mechanism must be 452 N.

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