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Determination of Traction Resistance of Disc Rollers of Combined Machine

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ABSTRACT: The article presents the results of theoretical studies to determine the traction resistance of the disk rollers of a combined machine for preparing freshly plowed fields for sowing.

KEY WORDS: combined machine for preparing freshly plowed fields for sowing, disk rollers, leveler, slatted roller, traction resistance of disk rollers.

I.INTRODUCTION

We have developed a combined machine for preparing freshly plowed fields for sowing. It consists of disk rollers mounted on a common frame, an equalizer and a plate roller. In the process of its operation, the disk rollers first crush the upper and compact the lower layers of the plowed field, then the leveler smoothes its surface, after which the slatted roller on the field surface creates a mulching (finely crumpled) layer to prevent moisture evaporation.

II.LITERATURE SURVEY

The article presents the results of theoretical studies to determine the traction resistance of the disk rollers of a combined machine.

Imonkulov K.B. In effort to reduce soil tillage machines energy consumption and consequently the power costs spent for tillage it is reasonable to ensure the interaction of their operating elements with soil in condition of the free cutting i.e. they must influence onto ground layers, having opened furrows or loosened zones at lateral sides.

III.METHODOLOGY

The traction resistance of the disk rollers in general can be expressed as

$$R_o = \left(\frac{B}{l} + 1\right) R_\partial , \qquad (1)$$

where R_o is the total traction resistance of the disk rollers, N;

B - the width of the machine, m;

l -the width between the disks, m;

R_d- traction resistance of one disk, N.

The cutting edges of the disks of the disk rollers are pointed, i.e. chamfers. Therefore,

$$R_\partial = R_л + R_з , \qquad (2)$$

where $R_л$, $R_з$ - traction resistance of the disk arising from the forces acting respectively on its blade and the pointed part (chamfers), N.

First we define $R_л$. To do this, we select from the part of the disk blade that interacts with the soil (see diagram *a* in the figure) the elementary area $ds_л = R\delta d\alpha_л$ (where R is the radius of the disk, m; δ is the thickness of the blade of the disk, m; $d\alpha_л$ - elementaryangle, radian).An elementary normal force acts on this area from the side of the soil

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$$dN_{л} = q_{л} ds_{л} = q_{л} \delta R d\alpha_{л}, \quad (3)$$

where $q_{л}$ is the specific pressure of the soil on the disk blade, Pa.
Obviously, $R_{л}$ is equal to the sum of the horizontal components of the elementary normal forces acting on the blade of the disk, i.e.

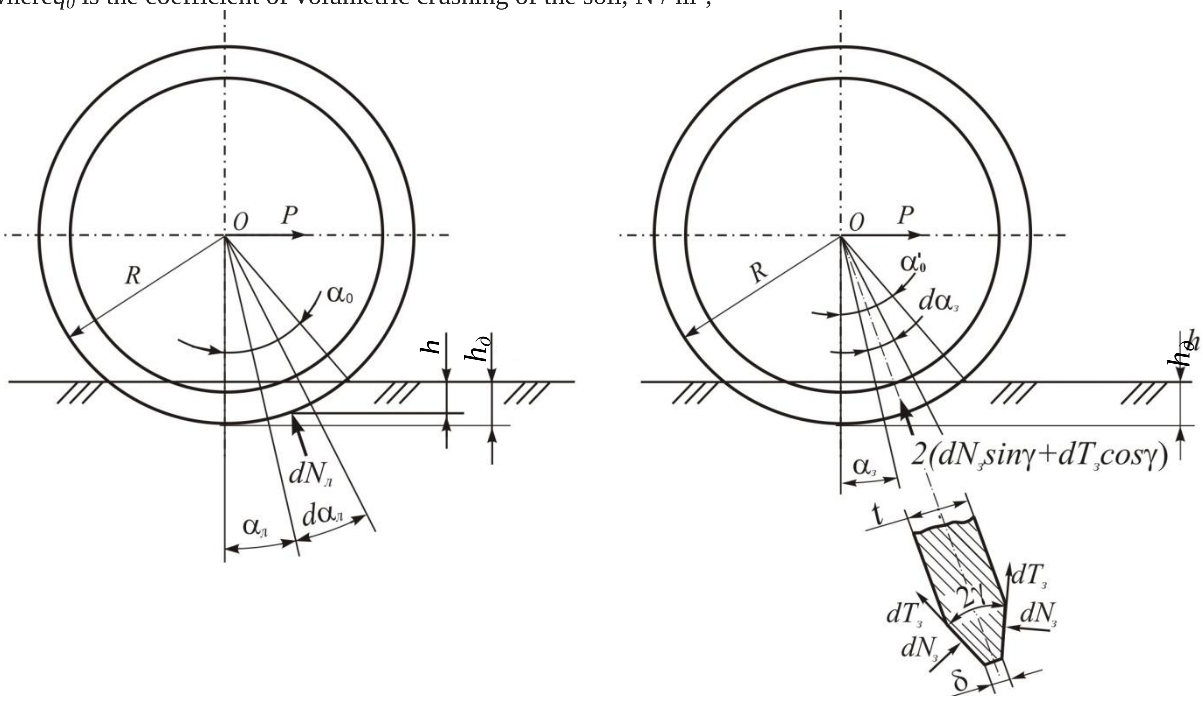
$$R_{л} = \sum dN^{г} = \int_{0}^{\alpha_0} dN_{л} \sin\alpha_{л} = \int_{0}^{\alpha_0} q_{л} \delta R \sin\alpha_{л} d\alpha_{л}, \quad (4)$$

where $dN^{г}$ - the horizontal component of the elementary normal force, acting on the blade of the disk, N;
α_0- the angle of the grasp of the blade of the disk by the soil, degrees;
$\alpha_{л}$- the angle that determines the position of the elementary angle to the vertical, degrees.

In expression (4) $q_{л}$ is expressed through the coefficient of volumetric crushing of the soil, the magnitude of its deformation and the speed of the machine [1-3]

$$q_{л} = \frac{q_0 \left(1 + \kappa V^2\right) h}{\cos\alpha_{л}}, \quad (5)$$

where q_0 is the coefficient of volumetric crushing of the soil, N / m^3;



a) *b)*

Schemes for the definition of $R_{л}(a)$ and $R_{з}$ *(b)*
k - coefficient of proportionality, s^2 / m^2;
V -the speed of the machine, m / s;
h -the amount of indentation (deformation) of the soil by the blade of the disk.
From scheme *a* in the figure

$$h = R(\cos\alpha_{л} - \cos\alpha_0). \quad (6)$$

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In view of (5) and (6), expression (4) has the following form

$$R_{л} = q_0\left(1+\kappa V^2\right)\delta R^2\left[1-(1-\ln\left|\cos\alpha_0\right|)\cos\alpha_0\right]. \qquad (7)$$

Expressing $cos\alpha_0$ in terms of the known R and h_{∂} (where hd is the depth of the disk), we finally have

$$R_{л} = q_0\left(1+\kappa V^2\right)\delta R^2\left[1-\frac{R-h_{\partial}}{R}(1-\ln\frac{R-h_{\partial}}{R})\right]. \qquad (8)$$

Using scheme b in the figure in the same way we determine the traction resistance of the disk arising from the forces acting on its pointed part

$$R_{з} = q_0\left(1+\kappa V^2\right)(R-\frac{t-\delta}{4}ctg\gamma)\left[R^2-\left(R-\frac{t-\delta}{2}ctg\gamma\right)^2\right]\times$$

$$\times\left[1-\frac{R-h_{\partial}}{R-\frac{t-\delta}{4}ctg\gamma}\left(1-\ln\frac{R-h_{\partial}}{R-\frac{t-\delta}{4}ctg\gamma}\right)\right](f+ctg\gamma), \qquad (9)$$

where$t$ is the thickness of the disk, m; γ- half of the point angle of the disk, degrees; f is the coefficient of friction of the soil on the disk material. Substituting the obtained values of $R_{л}$ and $R_{з}$ in (1), we have

$$R_0 = \left(\frac{B}{l}+1\right)q_0\left(1+\kappa V^2\right)\left\{\delta R^2\left[1-\frac{R-h_{\partial}}{R}\left(1-\ln\frac{R-h_{\partial}}{R}\right)\right]+\right.$$

$$+\left(R-\frac{t-\delta}{4}ctg\gamma\right)\left[R^2-\left(R-\frac{t-\delta}{2}ctg\gamma\right)^2\right]\times$$

$$\left.\times\left[1-\frac{R-h_{\partial}}{R-\frac{t-\delta}{4}ctg\gamma}\left(1-\ln\frac{R-h_{\partial}}{R-\frac{t-\delta}{4}ctg\gamma}\right)\right](f+ctg\gamma)\right\}. \qquad (10)$$

IV.EXPERIMENTAL RESULTS

From this expression it follows that the traction resistance of the rollers of the combined machine depends on the width of its grip, the width of the track between the disks, their thickness, radius, angle of sharpening, depth of travel and physico-mechanical properties of the soil. The calculations carried out by (10) for B = 3 m, l = 0,1 m, q_0 = 1,2·10^6N/m^3, γ= 30^0, q_0= 3·10^6N/m^3, f = 0,5, R = 0,25m,

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δ= 0,004 m, t = 0,02m [4, 5] showed that within the range of the disk stroke of 5-6 sm, the traction resistance of the disk rollers per 1 m of their working width is 0.82-0.93 kN.

V.CONCLUSIONS

1. The traction resistance of the disk rollers of a combined machine depends on the width of its grip, the width of the track between the disks, their thickness, radius, angle of sharpening, depth of travel and physical and mechanical properties the soil.
2. Within the range of 5-6 cm disc travel, the traction resistance of the disc rollers of the combined machine per 1 m of their working width is 0.82-0.93 kN.

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