ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 3 , March 2021

Determination of the Depth of Immersion in the Ground of the Support Wheel of the Suspension Fork

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ABSTRACT. The article presents the results of theoretical studies on the influence of the four-body suspension fitting support wheel designed for all-wheel drive tractors of class 3-4, the width and diameter of its node and the speed of the unit on the depth of immersion in the soil.

KEYWORDS. suspension fork, support wheel, width and diameter of the support wheel assembly, vertical pressure force, static volume coefficient of ground crushing, speed of the unit.

I.INTRODUCTION

It is known from the literature [1-5] that in order for the suspension fork to work, sinking to a given depth and moving steadily (evenly) at this depth, its support wheel must constantly press against the surface of the field, while the vertical pressure force on the ground, i.e. on the support wheel, must have a certain optimal value, that is,

$$Q_Z = Q_M , \qquad (1)$$

where is the vertical pressure force applied to the soil by the base wheel of the fork, N; - the optimal value of the vertical pressure force applied to the soil by the base wheel of the fork, which ensures the stability of the processing depth (drive), N.

It should be noted that even if the support wheel $Q_Z < Q_M$ of the plug can not adequately adapt to the irregularities of the field surface, while $Q_Z > Q_M$ dragging the plug consumes excess energy.

II. LITERATURE SURVEY

The depth of the fork drive when the condition(1) is met is mainly achieved by changing the depth of immersion of the support wheel in the soil [5-9]. Based on this, we investigate the depth of immersion of the buried support wheel in the ground. We look at this as the fact that the support wheel of the fork has a rigid node, that is, it does not deform.

III. METHODOLOGY

Let the support wheel of the fork move along the field, forming a trace at a depth of h_0(Fig. 1). $dS=B_m dl$ from the section of the base wheel node that is in interaction with the ground (where B_m - is the width of the node of the connected base wheel, m; dl is the elementary section, m), we separate the elementary surface. The force of the elementary reaction of the soil acting on this surface will be equal to

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$$dN = qB_m dl\,, \qquad (2)$$

where$q$ - is the relative ground pressure on the fork support wheel assembly, *Pa*;

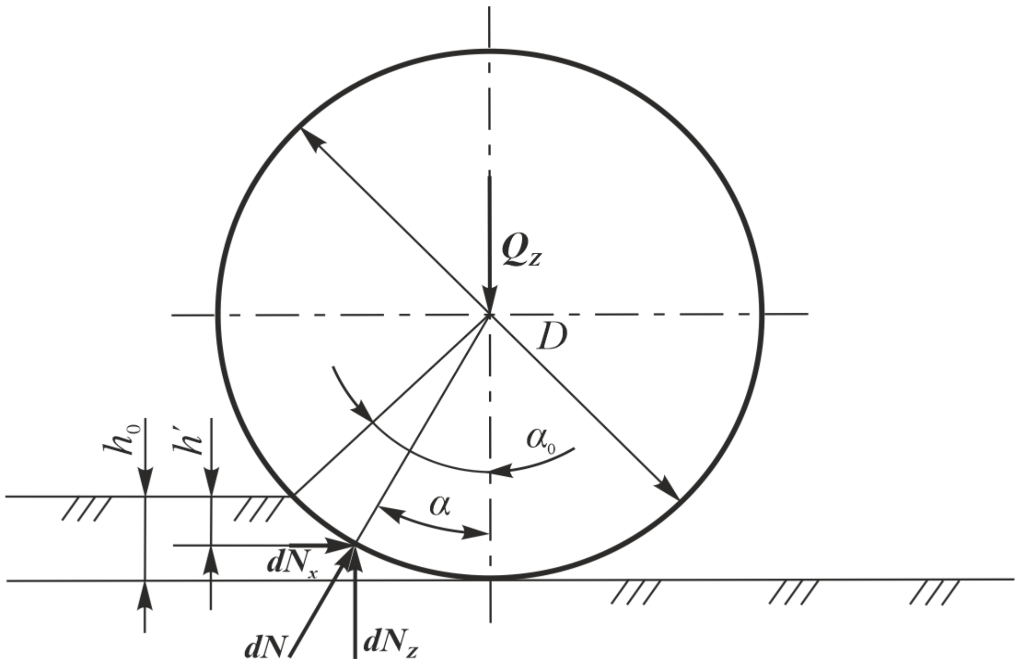

Figure 1. Scheme for determining the depth of immersion of the buried support wheel in the ground

It is known from the literature [4, 10] that the specific ground pressure on the support wheel assembly, taking into account the speed of the unit, will be equal to

$$p = \frac{p_m}{\cos\alpha} = \frac{q_0 h'\left(1 + kV_a^2\right)}{\cos\alpha} \qquad (3)$$

in this case, p_m is the specific resistance of the soil to vertical crushing, *Pa;* q_0 is the static volume coefficient of crushing of the ball bearing, N / m^3; - vertical deformation of the soil at the point under consideration, m; k is the proportionality coefficient, c^2/m^2; V_a –the speed of the unit, m/s; α - the central angle, degree, which determines the position of the elementary surface separated from the part of the support wheel assembly in contact with the ball, relative to the vertical diameter of the support wheel.

When considering expression (3), expression (2) will have the following form

$$dN = \frac{q_0 h' B_m \left(1 + kV_a^2\right) dl}{\cos\alpha} \qquad (4)$$

According to the scheme in Figure 1

$$h' = \frac{D}{2}\left(\cos\alpha - \cos\alpha_0\right); \qquad (5)$$

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$$dl = \frac{D}{2} d\alpha , \quad (6)$$

where D- is the diameter of the main wheel of the plug, m; α_0-is the angle of immersion of the base wheel in the ground, degree, $d\alpha$- the elementary angle of subtraction, degree.

Taking into account expressions (5) and (6), expression (4) will look like this

$$dN = \frac{q_0 B_m D^2 \left(1 + kV_a^2\right)\left(\cos\alpha - \cos\alpha_0\right)}{4\cos\alpha} d\alpha \quad (7)$$

We will divide it dN into vertical dN_Z and horizontal dN_X organizers. The sum $\sum dN_Z$ of the vertical components will be equal to the force of the vertical pressure exerted Q_Z on the ground by the support wheel, i.e.

$$Q_Z = \sum dN \cos\alpha = \int_0^{\alpha_0} \frac{q_0 B_m D^2 \left(1 + kV_a^2\right)\left(\cos\alpha - \cos\alpha_0\right)}{4} d\alpha \quad (8)$$

Integrating the right-hand side of expression (8) in the range from 0 to α_0, we get the following result

$$Q_Z = \frac{q_0 B_m D^2 \left(1 + kV_a^2\right)}{4}\left(\sin\alpha_0 - \alpha_0 \cos\alpha_0\right) \quad (9)$$

From the diagram in Figure 1

$$\sin\alpha_0 = \frac{2\sqrt{Dh_0 - h_0^2}}{D} ; \quad (10)$$

$$\alpha_0 = \arcsin\frac{2\sqrt{Dh_0 - h_0^2}}{D} ; \quad (11)$$

and

$$\cos\alpha_0 = \frac{D - 2h_0}{D} . \quad (12)$$

Given expressions (10)-(12), expression (9) will have the following form

$$Q_Z = \frac{q_0 B_m D\left(1 + kV_a^2\right)}{4}\left(2\sqrt{Dh_0 - h_0^2} - \left(D - 2h_0\right)\arcsin\frac{2\sqrt{Dh_0 - h_0^2}}{D}\right) . \quad (13)$$

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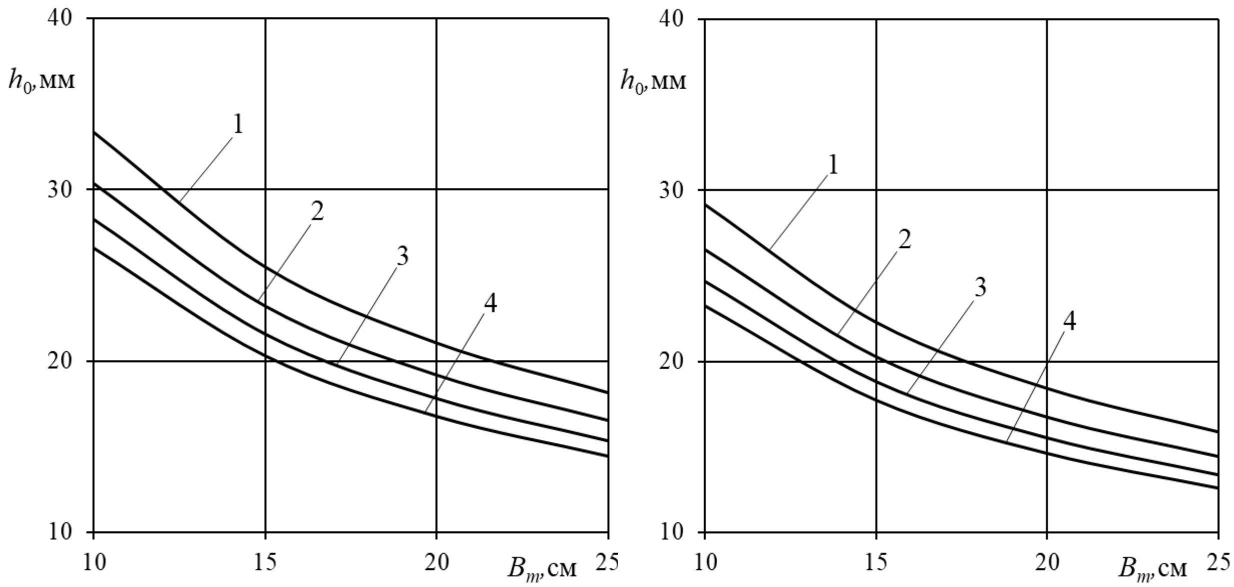
IV.EXPERIMENTAL RESULTS

For a four-body suspension fork aggregated with wheeled tractors of 3-4 classes $Q_Z = Q_M$ = 5,5 kN, $q_0 = 2\cdot10^7$ N/m^3[2-3], the speed of the unit V_a = 6 and 9 km/h and the proportionality coefficient k = 0,08 [9], numerical methods for solving (13) were adopted and applied. Graphs of the change in the depth of immersion B_m of the support wheel of the fork in the soil h_0 at different values of D are plotted (Figure 2). Depending on the data obtained, as the width and diameter of the wheel assembly increased, the depth of its immersion in the ground decreased.



a)*b*)

1-d_T = 40 cm; 2-d_T = 50 cm; 3-d_T = 60 cm; 4-d_T = 70 cm;
a, b - speed of 6 and 9 km / h, respectively

Figure 2. Graphs of the change in the depth of immersion of the buried support wheel in the ground, depending on its diameter and the width of the node

The increase in speed from 6 km / h to 9 km / h also reduced the depth of immersion of the base wheel in the ground.

According to the current agrotechnical requirements, the deviation of the plowing depth from the specified one should not exceed ±2 cm. To do this, as the graphs shown in Figure 2 show, the width of the fork wheel assembly must be at least 22 cm, and the diameter must be at least 40 cm.

V.CONCLUSION

The conducted studies have shown that in order for a four-body suspension fork aggregated with class 3-4 wheeled tractors to be able to move evenly along the drive depth at speeds of 6 and 9 km / h, the width and diameter of its support wheel assembly must be at least 22 and 40 cm, respectively.

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