THEORY OF SUPPORT APPLICATION
FOR HIGHER GRAVITATIONAL QUALITY INDICATORS
IN WHEEL TRACTORS

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Summary. Theoretically grounded improvement of quality indicators in wheel traction-engine vehicles by using gravitational energy.

Key words: engine, wheel, gravity, frequency, weight, speed, angle, radius.

INTRODUCTION

The issue of cost structure for army wheeled tractors concerns an improvement of traction capabilities, the increased SAC wheel engine and has been experimentally solved by scientists.

The aspects of the creation of new types of a wheeled vehicle for the elderly and modernization in order to improve SAC engines are widely considered [1, 4, 6, 9] as a theoretical issue of the work of the wheeled propeller, and the practical problems in dealing with the cost of engine power, engine durability of the wheel, the dynamic loads of additional interaction with the lead wheel at resistance work.

We [19] have proposed a method of gravitational improvement of traction capabilities in a wheel tractor without dramatic changes in the value of tangential forces at the wheel traction engine, through its arc treatment out of the gravitational moment.

ANALYSIS OF PUBLICATIONS

The authors of many studies [1-4, 6-10, 12, 13] have suggested that the use of wheeled tractors in agricultural production is a priority. It was found out that when the wheels were attached to the force or braking torque, a lack of communication of the wheel rim with the ground caused that it began to slide, or its path was characterized by traversed axis of the wheel, in which case there should be more arc treatment. When the wheels reach the leading time, there is insufficient adhesion force with the ground and it is beginning to rival the wheel, or its arc lamps become more ways, which deforms axis.

The strength of the turning wheels is evaluated by some relevant factors: coefficient of sliding $\varepsilon$, 

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*References* [1, 4, 6, 9, 19]
\[ \varepsilon = \frac{\Delta r \cdot \Delta \alpha}{\Delta s} = \frac{\Delta r}{r + \Delta r} \]  \hspace{1cm} (1) \\

Gain wheel:

\[ \delta = \frac{\Delta r \cdot \Delta \alpha}{\Delta r} = \frac{\Delta r}{r - \Delta r} \]  \hspace{1cm} (2)

where: \( \Delta s \) – the traversed path of wheel axle; 
\( \Delta \alpha \) – angle of the wheel; 
\( r \) – radius of the wheel; 
\( \Delta r \) – increase of the wheel radius in time.

The strength of the resistance movement [14] wheel is proportional to the applied vertical load and back is proportional to the diameter and width of the wheel, and the coefficient of volumetric soil samples. The calculated dependence of the force of resistance, coefficient of resistance movements, as well as the gauge depth of vertical loads are reviewed in [15]. As shown in graphic dependencies (Fig.1), the resistance increases with the growth of intensive vertical load \( G \), although the intensity of growth with increasing \( G \) decreases.

Fig. 1. Dependence \( f, h \) and \( P_f \) the \( G \)

E.D. Lions [16], in order to determine the strength of resistance movements of elastic wheels, uses a special formula to harden the wheel rim. A number of researchers [2, 4] on the basis of the assumption that deformed ground contact area is close to the surface of a cylindrical, concluded that the pneumatic wheel can be replaced with conditional tight one, with an increase in diameter.

The possibility of replacing wheels with rigid pneumatic tyres was indicated by foreign researchers, such as M. Becker [17].

Each of the prerequisites has theoretical advantages and disadvantages. In modern times no precise relationships between the parameters of elastic wheel loads and physical and mechanical properties of soil have been found out which would provide the theoretical calculations with data on the quality of traction wheels and coincide with the actual properties of different soils as well as with the broad parameters of the wheels boundary changes and loads.

THEORETICAL STUDY RECOMMENDATIONS AND PATENT

By analyzing the interaction of flexible wheel with the ground, take into consideration the hard-wheel premise that rotates on deformed surface. Under such a premise one may use formulas to describe the working process of hard driving wheels.
When driving, wheels of tractor tires are not slipping and are not stalled on the ground, the speed of the wheel center rectilinear motion stems from its angular velocity \( n_k \) dependence:

\[
V = n_k \cdot r_d.
\]  

(3)

In a tractor, angular wheel velocity can be expressed in terms of the angular velocity of the engine:

\[
n_k = \frac{n_T}{j_p},
\]  

(4)

where:

- \( j_\text{tr} \) – tractor transmission gear ratio;
- \( j_\text{p} \) – gear ratio changes in transmission boxes;
- \( j_\text{m} \) – the main transmission gear ratio.

As is well known [14], no resistance to driving wheels:

\[
0 \leq F_r M, \quad (5)
\]

where:

- \( F_0 \) – the resistance skiing resistance;
- \( r \) – dynamic radius of the wheel.

Attitude \( M_f \) is conditional because of the resistance movement and the wheel determines the application of this moment of opportunity to improve the speed of the energy resources.

If the wheel engine needs additional equipment from leverage [20], it is partly because of the traction carry resistance ahead of skating phase on the surface of the geometric center of the wheel contact with a support surface engine in the vertical plane (Fig. 2).

During the working process, we proposed a method of increasing the capacity of the traction power tools, implemented in a way by moving wheel engine by means of tangential force of traction. At the time of wheel engine overloading (the pumps) traction resistance strength () clicks on the lever that moves at exactly the same time to a metal wheel rim engine with a force and is rotated around the axis of the wheel propulsion. There is a further point, which increases the traction possibilities. Such a technique, by the time of withdrawal, will have managed to cope with overload wheel propulsion.
We have proposed an alternative way to improve the traction capabilities of wheeled vehicles – using the gravitational energy [19], which creates a gravitational point. Its work is carried out as follows (Fig. 3).

From transmission to the driving wheel torque reaches 3. Through loader 18 gravitational torque is transmitted to the comparative bridge 10. At the time of the sharp increase in the number of turns, driving wheel 3 (overloaded by its tangential force of traction) compressed spring 22, and spring 12 are stretched. Thus girder 7 turns on the axis 17 along with the socket 16. With this technology reception loader gravitational assists to turn around 7 beams together with the boom 20 and gravitational energy 19. Gravitational energy denied the right, thereby relatively axis comparative bridge created by gravitational torque 10 slows an increase of frequency of 11-wheel comparative bridge 10. The process realizes high tangent traction control of springs 12 and 22-kardano telescopic compounds 13, 21 Bridge 7 gravitational force is rotated to the vertical position and decreases turning wheels. The effective use of the engine power reduces unit costs of fuel.

Fig. 3. Method of gravitational improvement of traction capabilities in a wheel tractor

MATHEMATICAL MODEL OF GRAVITATIONAL SUPPORT

Gravitational radius $R_1$ 19 (Fig. 3), between a wheel and a range of supports determine the speed of the driving wheel. It decides to what point gravitational energy deviates from the surface of the driving wheel in motion and comes freely to the surface-supported wheels.

Gravitational force moves on the surface of the driving wheel produced by the action of two forces:
- forces weight;
- leading surface reaction wheels.

The main dynamics of the equation is given by the gravitational force

$$m \cdot \ddot{\omega} = \mathbf{G} \cdot \mathbf{N},$$

(6)
and the equation of motion given the Eyler’s gravity formula will be:

\[ m \cdot \frac{d^2S}{dt^2} = G \cdot \sin\varphi, \]  

(7)

\[ m \cdot \frac{V^2}{R} = G \cdot \cos\varphi - N, \]  

(8)

where: 
- \( S \) – length of the arc at the wheel of propeller \( R_1 \), which is responsible for \( R_0 \) gravitational force pathways;
- \( \varphi \) – gravitational angle deviation from the starting position,
- \( R \) – degree of radii of the driving wheel and force,
- \( N \) – reaction wheel engine,
- \( G \) – gravitational weight,
- \( V \) – the speed of the wheels at any given time.

At the time of separation from the surface of the gravitational energy, wheel propulsion’s response will be equated to zero.

From the equation (8), with such dependence will:

\[ \frac{m \cdot V^2}{R} = G \cdot \cos\varphi. \]  

(9)

Then, from the equation (9), bend formula can be received:

\[ \cos\varphi = \frac{V^2}{g \cdot R}. \]  

(10)

To determine the square of velocity, formula (7) is used. In the beginning of the count arc coordinates \( S \) accept the initial position of gravitational energy (19). Then:

\[ S = M_0 \cdot M_1 = R \cdot \varphi, \]  

(11)

\[ \frac{d^2S}{dt^2} = R \cdot \frac{d^2\varphi}{dt^2} = R \cdot \frac{d\omega}{dt} = \frac{d\omega}{d\varphi} \cdot \frac{d\varphi}{dt} = R \cdot \frac{d\omega}{d\varphi} \cdot \omega. \]  

(12)

Substitute value \( \frac{d^2S}{dt^2} \) from the equation (7) and receive:

\[ m \cdot R \cdot \frac{d\omega}{d\varphi} \cdot \omega = m \cdot g \cdot \sin\varphi, \]  

(13)

or

\[ R \cdot \omega \cdot d\omega = g \cdot \sin\varphi d\varphi. \]  

(14)

Integrating equation (14):

\[ R \cdot \frac{\omega^2}{2} = -g \cdot \cos\varphi + C. \]  

(15)

Formula (15) expresses angular velocity through the linear velocity at the point of the formula \( M \):

\[ \omega = \frac{V}{R}. \]  

(16)
and obtains equation:
\[ \frac{v^2}{2R} = -g \cdot \cos \varphi + C. \]  
(17)

Perhaps there is a continuous integration of properties to determine the conditions of travel:
\[ \varphi_0 = 0; V = V_0. \]  
(18)

Then:
\[ \frac{v^2}{2R} = -g + C. \]  
(19)

Whence:
\[ C = \frac{v_0^2}{2R} + g. \]  
(20)

Substitute \( C \) value to the equation (17) and obtain the following dependence:
\[ \frac{v^2}{2R} = -g \cdot \cos \varphi + \frac{v_0^2}{2R} + g, \]  
or
\[ v^2 = v_0^2 + 2g \cdot R \cdot (1 - \cos \varphi). \]  
(22)

Substitute importance square velocity (22) in the formula (10) and get the following equation:
\[ \cos \varphi = \frac{\nu^2}{g \cdot R} = \frac{v_0^2}{g \cdot R} + 2 \cdot (1 - \cos \varphi). \]  
(23)

Whence:
\[ \cos \varphi = \frac{1}{3} \left( 2 + \frac{v_0^2}{g \cdot (R_1 + R_0)} \right). \]  
(24)

Thus, the angle of deviation of gravitational energy depends on the initial speed of force \( V_0 \), the radius of the driving wheel \( R_0 \) and \( R_1 \).

Calculations according to the angle of gravitational energy of initial speed were held in the MATLAB environment and are shown in Fig. 4.

![Fig. 4. The dependence of the gravitational angle of the initial speed](image-url)
CONCLUSIONS

1. Improvement of the quality of wheeled tractors indicators can be done most effectively by using gravitational energy.
2. Increase in the initial speed of the gravitational energy leads to an increase in its angle and thereby to an increase in the use of the gravitational energy.

REFERENCES

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