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THEORETICAL ANALYSIS OF THE DEPENDENCE OF TRACTION PROPERTIES ON THE MACHINE DRIVE CHARACTERISTICS

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Anotation:
The article presents the results of a theoretical analysis jn the influence of the wheel formula and the connection diagram of the propulsions on the traction and coupling properties of machines.

Keywords: wheel formula, engineering machine, cross-axle differential, technological operations, traction properties.

At present, earthworks are carried out using various engineering machines, combined units, which have high traction resistance and require significant power to drive the working bodies.

As a rule, these machines are used in conjunction with wheeled machines or, if they have an independent drive, are equipped with wheel propellers.

It should be noted the widespread use of a wheel mover for special equipment designed for soils with a weak bearing capacity.

The traction properties of wheeled vehicles largely depend on the wheel arrangement of their undercarriage, which determines the ratio between the number of driving wheels (or axles) and the total number of wheels (axles) of the vehicle.

Obviously, the more bridges out of the total number are leading, the more fully the coupling weight of the machine is used and the higher its traction properties, all other things being equal. So, for motor graders with a wheel arrangement of 1x2x3 or 1x1x2, the clutch utilization factor γp= 0.70. ... 0.75, and for motor graders with all driving axles (3x3x3 or 2x2x2) γp= 1.

Depending on the design of the transmission, the drive wheels of the machine may have a different relationship with each other. They can be interconnected using differential mechanisms, which, as is known, provide the possibility of rotating each wheel at a different speed, which is important, for example, when cornering, when the outer wheels of the machine with respect to the center of rotation travel a greater distance than the inner wheels. and therefore must have a high circumferential speed. Other transmissions have no or locked differentials; in this case, the wheels of each axle work together as interconnected by a rigid shaft.

The drive of the drive wheels can be performed according to the traditional scheme: from a common engine through the gearbox and distribution box, the torque is transmitted to the drive wheels, or according to the "motor-wheel" scheme, when each drive wheel is driven directly or through a gearbox from an individual electric motor or hydraulic motor.

The different kinematic connection between the propulsors of the machine causes certain differences in its traction properties.

For a two-axle vehicle with a 4x4 wheel formula, the maximum tractive effort for adhesion

$$Tсц = (Rk1 + Rk2)\ φсцmin, \quad (1)$$

where Rk1 and Rk2 are the normal reactions of the rolling surface on the front and rear wheels of the machine; φsc min is the minimum adhesion coefficient.

If there is no interaxle differential between the driving wheels of the front and rear axles or this differential is blocked, and the interwheel differentials of each axle distributing the torque between the left and right driving wheels are not blocked, then the maximum tractive effort that can be realized according to the condition of adhesion of the propellers to the surface rolling, will be limited by the adhesion of the wheels, for which the value of the friction coefficient φsc will be minimal

$$Tсц = Rk1\ φсц\ 1min + Rk2\ φсц\ 2min, \quad (2)$$

where φsc 1min are the minimum friction coefficients for the driving wheels of the front and rear axles of the machine, respectively.

In the absence or blocking of inter-axle and inter-wheel differentials, the maximum traction force of the machine for the adhesion of its propellers to the rolling surface

$$Tсц = RkА\ φсц\ А + RkБ\ φсц\ Б + RkВ\ φсц\ В + RkД\ φсц\ Д =, \quad (3)$$

where RkA , RkB , RkB , RkD are the normal reactions of the rolling surface on each drive wheel; φsc A , φsc B , φsc B , φsc D are friction coefficients for the corresponding wheels; n is the number of driving wheels.

As you can see, with locked differentials, the maximum traction force of the machine will depend only on the adhesion forces of each drive wheel with the rolling surface.

For a machine with a 4x2 wheel formula, for which the coupling weight is Gst = G2, where G2 is the weight falling on its drive axle, the maximum traction force for adhesion with an unlocked differential

$$Tсц = G2\ φсц\ min. \quad (4)$$

With an interwheel locked differential and RkB = RkD = G2/2, we get

$$T'сц = RkВ\ φсц\ В + RkД\ φсц\ min = \frac{G_2}{2}(φсц\ В + φсц\ min). \quad (5)$$

The degree of increase in the limiting traction force when blocking the interwheel differential is characterized by the ratio (6)

For a three-axle machine with all driving wheels (wheel formula 6x6) when connecting the driving axles and the wheels of each axle through differentials, the maximum traction force

$T_{сц} = (R_{k1} + R_{k2} + R_{k3})\ \varphi_{сц\ min}$, (7)

where R_{k1}, R_{k2}, R_{k3} are the normal reactions of the rolling surface on the wheels of the first, second and third driving axles.

When blocking or the absence of an interaxle differential and the presence of an interwheel differential

$T_{сц} = R_{k1}\ \varphi_{сц1min} + R_{k2}\ \varphi_{сц\ 2min} + R_{k3}\ \varphi_{сц\ 3min}$, (8)

those. in this case, the traction force developed by the machine depends on the traction forces of each pair of wheels, and is not limited to the minimum traction of a wheel located on a slippery section of the road.

The traction properties of machines can also be estimated by the traction efficiency of the machine η_t, which is equal to the ratio of the traction power N_t at a given time to the corresponding engine power N_d,

$$\eta_t = \frac{N_t}{N_d} = \frac{N_t}{N_p}\eta_k\ \eta\ , \qquad (9)$$

where η_k is the efficiency of the propeller; N_p is the power on the hook.

Thus, a theoretical analysis of the influence of the wheel formula and the connection scheme of the propellers on the traction properties of the machine shows that the traction efficiency of the machine, in contrast to the efficiency of the propeller, which depends only on the parameters of the wheel and the physical and mechanical properties of the rolling surface, also depends on the characteristics of the drive of the machine.

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