DEPENDENCE OF THE MOTOR CONNECTION DIAGRAM ON THE TRACTION PROPERTIES OF THE MACHINE

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Abstract: *as you know, the traction properties of wheeled vehicles largely depend on the wheel formula of their chassis, which determines the ratio between the number of driving wheels (or bridges) and the total number of wheels (bridges) of the machine. Obviously, the more of the total number of axles are leading, the more fully the adhesion weight of the machine is used and the more, all other things being equal, the higher its traction properties.*

The article presents the results of a theoretical analysis on the influence of the wheel arrangement and the connection diagram of the propellers on the traction-coupling properties of machines.

Keywords: *wheel arrangement, engineering vehicle, inter-wheel differential, technological operations, traction properties.*

ЗАВИСИМОСТЬ СХЕМЫ СОЕДИНЕНИЯ ДВИГАТЕЛЕЙ ОТ ТЯГОВЫХ СВОЙСТВ МАШИНЫ

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Аннотация: *как известно, тяговые свойства колесных машин во многом зависят от колесной формулы их ходовой части, определяющей соотношение между числом ведущих колес (или мостов) и общим числом колес (мостов) машины. Очевидно, что чем больше мостов из общего числа являются ведущими, тем полнее используется сцепной вес машины и тем, при прочих равных условиях, выше ее тяговые свойства.*

В статье приводятся результаты теоретического анализа по влиянию колесной формулы и схемы соединения движителей на тягово-сцепные свойства машин.

Ключевые слова: *колесная формула, инженерная машина, межколесный дифференциал, технологические операции, тяговые свойства.*

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At present, various engineering machines, combined units with high traction resistance and requiring significant power to drive the working bodies, are used for earthwork [1].

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

It should be noted the widespread use of a wheeled propeller for special equipment designed for soils with a weak bearing capacity [2].

Traction properties of wheeled vehicles largely depend on the wheel formula of their chassis, which determines the ratio between the number of driving wheels (or bridges) and the total number of wheels (bridges) of the machine.

Obviously, the more of the total number of axles are leading, the more fully the adhesion weight of the machine is used and the more, all other things being equal, the higher its traction properties. So, for motor graders with wheel formula 1x2x3 or 1x1x2, coefficient of clutch utilization γ_p = 0.70 ... 0.75, and for motor graders with all driving axles (3x3x3 or 2x2x2) $\gamma_p = 1$ [3].

Depending on the design of the transmission, the drive wheels of the machine can have a different connection with each other. They can be interconnected by means of differential mechanisms that provide, as is known, the possibility of rotation of each wheel at a different speed, which is important, for example, when cornering, when the outer wheels of the machine travel more than the inner wheels. and therefore, must have a high peripheral speed. In other transmissions, differentials are missing or locked; in this case, the wheels of each axle work together as interconnected by a rigid shaft [4].

The drive of the drive wheels can be performed according to the traditional scheme: from a common engine through a gearbox and a 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.

Different kinematic connections between the propellers of the machine cause certain differences in its traction properties.

For a two-axle machine with a 4x4 wheel arrangement, maximum tractive effort for traction

$$T_{\text{сц}} = (R_{k1} + R_{k2})\, \varphi_{\text{сц}\ min}, \qquad (1)$$

where R_{k1} and R_{k2} are the normal reactions of the rolling surface on the front and rear wheels of the machine; $\varphi_{\text{сц}\ min}$ is the minimum coefficient of adhesion.

If there is no center differential between the driving wheels of the front and rear axles or this differential is blocked, and the cross-axle differentials of each axle that distribute the torque between the left and right driving wheels are not blocked, then the maximum tractive effort that can be realized by 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 coefficient of adhesion $\varphi_{\text{сц}}$ will be minimal

$$T_{\text{сц}} = R_{k1}\, \varphi_{\text{сц}1min} + R_{k2}\, \varphi_{\text{сц}2min}, \qquad (2)$$

where $\varphi_{\text{сц}1min}$ and $\varphi_{\text{сц}2min}$ are the minimum coefficients of adhesion for the driving wheels, respectively, of the front and rear axles of the machine.

In the absence or blocking of interaxle and cross-axle differentials, the ultimate tractive effort of the machine for adhesion of its propellers to the rolling surface

$$T_{\text{сц}} = R_{kA}\, \varphi_{\text{сц}A} + R_{k\text{Б}}\, \varphi_{\text{сцБ}} + R_{kB}\, \varphi_{\text{сц}B} + T_{k\text{Д}}\, \varphi_{\text{сцД}} = \sum_1^n R_{ki}\, \varphi_{\text{с ц}\, i}\,, \qquad (3)$$

where R_{kA}, $R_{k\text{Б}}$, R_{kB}, $T_{k\text{Д}}$ - normal reactions of the rolling surface on each drive wheel; $\varphi_{\text{сц}A}$, $\varphi_{\text{сцБ}}$, $\varphi_{\text{сц}B}$, $\varphi_{\text{сцД}}$ - adhesion coefficients for the corresponding wheels; n is the number of driving wheels.

As you can see, with locked differentials, the ultimate tractive effort of the machine will depend only on the adhesion forces of each drive wheel to the rolling surface.

For a car with a 4x2 wheel arrangement, for which the adhesion weight is $G_{\text{сц}} = G_2$, where G_2 is the weight on its driving axle, the ultimate tractive effort for adhesion with an unlocked differential

$$T_{\text{сц}} = G_2\, \varphi_{\text{сц}\ min.} \qquad (4)$$

With an interwheel locked differential and $R_{kB} = R_{k\text{Д}} = G_2 / 2$, we get

$$T'_{\text{сц}} = R_{kB}\, \varphi_{\text{сц}\ B} + R_{\text{кД}}\, \varphi_{\text{сц}\ min} = \frac{G_2}{2}\,(\varphi_{\text{сц}\ B} + \varphi_{\text{сц}\ min}). \qquad (5)$$

The degree of increase in the ultimate tractive effort when blocking the interwheel differential is characterized by the ratio

$$\frac{T'_{\text{с ц}}}{T_{\text{с ц}}} = \frac{0{,}5\text{С}_2(\varphi_{\text{с ц}\ B} + \varphi_{\text{с ц}\ min})}{G_2 \varphi_{\text{с ц}\ min}} = \frac{0{,}5(\varphi_{\text{с ц}\ B} + \varphi_{\text{с ц}\ min})}{\varphi_{\text{с ц}\ min}} \qquad (6)$$

For a three-axle machine with all driving wheels (wheel arrangement 6x6), when driving axles and wheels of each axle are connected through differentials, ultimate tractive effort

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

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.

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

$$T_{\text{сц}} = R_{k1}\, \varphi_{\text{сц}\ 1min} + R_{k2}\, \varphi_{\text{сц}\ 2min} + R_{k3}\, \varphi_{\text{сц}\ 3min}, \qquad (8)$$

i.e. in this case, the tractive effort developed by the machine depends on the adhesion forces of each pair of wheels, and is not limited to the minimum adhesion of a wheel located on a slippery road.

The traction properties of machines can also be estimated by the traction efficiency of machines ηt, 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 mover; N_p is the power on the hook.

Thus, the theoretical analysis of the influence of the wheel arrangement and the connection diagram of the propellers on the traction-coupling 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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