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CALCULATION OF A CYLINDRICAL SURFACE THAT ENSURES A CONSTANT THRUST OR A CONSTANT AMOUNT OF PRESSURE OF A PARTICLE OF MATERIAL MOVING THROUGH IT AT A CONSTANT SPEED

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Abstract. *There are known studies in which the movement of material particles along gravitational surfaces is considered. The speed of movement along the curve in such cases is variable. However, in agricultural machines, there may be cases where a particle moves along a surface at a constant speed. In this case, in addition to the force of gravity, the force of traction acts on the particle.*

The purpose of the study is the calculation of a cylindrical surface that provides a constant traction force or a constant pressure value of a material particle moving along it at a constant speed.

Curves were found along which a particle moving at a constant speed will exert a constant pressure or the active traction force will be constant.

Equations have been found and curves have been constructed that ensure a constant force of traction or a constant amount of pressure of a material particle moving along a curve at a constant speed.

These curves will retain their properties only if the value of the calculated speed is strictly observed. This is explained by the fact that in the equations of the curves, the speed value is squared, so even a slight deviation from the calculated one will cause a significant deviation of the expected results.

Key words: *material particle, cylindrical surface, weight force, traction force, speed*

Topicality. The movement of material particles on non-gravitational surfaces occurs in many agricultural machines. Therefore, it is important to know the movement of a particle along such a surface.

Analysis of recent research and publications. The movement of material particles along gravitational surfaces is considered in monographs [1, 2]. Since it is implied that the surfaces are cylindrical with a horizontal arrangement of the generators, the movement of particles can be studied on flat curves - orthogonal sections of these surfaces. In the corresponding sections of the mentioned works, such surfaces and curves are called gravitational surfaces, because the movement of a particle is determined by the force of its weight. The speed of movement along the curve in such cases is variable. However, in agricultural machines, there may be cases when a particle moves along the surface at a constant speed (for example, during the forced movement of soil particles along the surface of the working body [3]). In this case, in addition to the force of gravity, another active force F_{tg} (traction force) acts on the particle. Let's find such curves when moving along which a particle will 1) exert a constant pressure; 2) the active force F_{tg} will be constant. Obviously, such curves will no longer be gravitational.

The purpose of the study is the calculation of a cylindrical surface that provides a constant force of traction or a constant value of pressure of a material particle moving along it at a constant speed.

Materials and methods of research.

1. Curves providing a constant pressure at a constant speed of particle movement.

Suppose that under the action of the force F_{tg}, a soil particle moves up the curve with a constant speed *v* (Fig. 1). Let's find the equation of the curve that, at a given speed *v*, will provide a constant reaction F_{tg} of the surface, that is, a constant pressure on the surface. In practical terms, such a surface will wear evenly and will be less prone to soil sticking. We project all acting forces onto the main normal $\bar{n}$ curves:

$$mg\cos\alpha + mv^2k = F_{tg}, \tag{1}$$

where *k is* the curvature of the curve at this point, *m* is the mass of the particle, *g = 9.81 m/s* ^{2}.

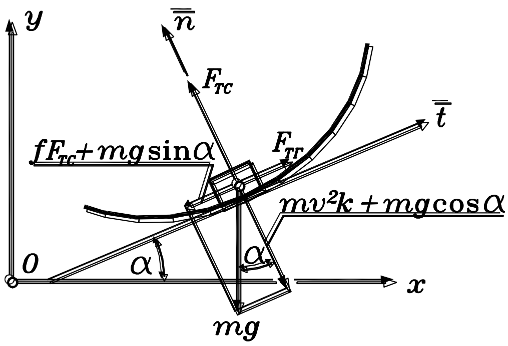

Fig. 1. Decomposition of acting forces into main normal $\bar{n}$ and tangent $\bar{t}$ curve

Let's rewrite equation (1), dividing the left and right parts by the force of weight *mg* and writing the curvature *k* through the known relation from differential geometry $k=\frac{d\alpha}{ds}=1:\frac{ds}{d\alpha}=\frac{1}{s'}$, where *s* is the length of the arc of the curve:

$$\cos\alpha+\frac{v^2}{s'g}=\frac{F_{\text{tg}}}{mg}. \qquad (2)$$

The ratio F_{ts} / *mg* is a constant value, it shows what fraction of the weight of the particle is the force of pressure on the surface. We denote it by a_{ts} *and* solve equation (2) with respect s' to :

$$\frac{ds}{d\alpha}=\frac{v^2}{g(a_{\text{пс}}-\cos\alpha)}, \text{ so } k=\frac{g}{v^2}(a_{\text{тс}}-\cos\alpha). \qquad (3)$$

Integration of expression (3) is possible for two cases: $a_{\text{ts}}>1$ (that is, the pressure on the surface is greater than the weight of the particle) and $a_{\text{ts}}<1$ (the pressure is less than the weight of the particle). Let's write down the corresponding integrals (we omit the constant integration):

$$s=\frac{v^2}{g}\int\frac{d\alpha}{a_{\text{тс}}-\cos\alpha}=\frac{2v^2}{g\sqrt{a_{\text{тс}}^2-1}}\operatorname{arctg}\sqrt{\frac{a_{\text{тс}}+1}{a_{\text{тс}}-1}}\operatorname{tg}\frac{\alpha}{2}, \qquad (a_{\text{тс}}>1)$$

$$s=\frac{v^2}{g}\int\frac{d\alpha}{a_{\text{тс}}-\cos\alpha}=\frac{v^2}{g\sqrt{1-a_{\text{тс}}^2}}\ln\frac{(1+a_{\text{тс}})\operatorname{tg}\frac{\alpha}{2}-\sqrt{1-a_{\text{тс}}^2}}{(1+a_{\text{тс}})\operatorname{tg}\frac{\alpha}{2}+\sqrt{1-a_{\text{тс}}^2}}. \quad (a_{\text{тс}}<1) \qquad (4)$$

Equations (4) $s=s(\alpha)$ specify the regularity of the change of the angle αalong the arc of the curve, therefore, determine the curve by its internal properties regardless of its location in the rectangular coordinate system. In differential geometry, a different notation of curves is accepted by its internal equation - the dependence of the curvature on the length of the arc $k=k(s)$. Such an equation is called a natural curve equation. We will obtain it for both cases if we exclude the common parameter in the right-hand equation (3) and equations (4) α:

$$k = \frac{g(a_{\text{tg}}^2 - 1)}{v^2\left[a_{\text{tg}} + \cos\left(\frac{g}{v^2}\sqrt{a_{\text{tg}}^2 - 1}\, s\right)\right]}; \qquad (a_{\text{tg}} > 1) \tag{5}$$

Natural equations (5) define curves regardless of their position and orientation on the plane. This means that when the curve is turned by a certain angle, εits natural equation does not change. For us, this form of recording is not acceptable, since the orientation of the curve in the plane will depend on the vectors of the applied forces, so let's move on to the coordinate form of recording. The connection of natural equations with rectangular coordinates is described by the dependencies known in differential geometry:

$$\frac{dx}{ds} = \cos\alpha; \qquad \frac{dy}{ds} = \sin\alpha. \tag{6}$$

Let's rewrite dependencies (6), moving to the independent variable α*:*

$$\frac{dx}{d\alpha}\frac{d\alpha}{ds} = \cos\alpha, \text{ звідки } \frac{dx}{d\alpha} = \frac{ds}{d\alpha}\cos\alpha.$$

$$\text{Similarly } \frac{dy}{d\alpha} = \frac{ds}{d\alpha}\sin\alpha. \tag{7}$$

By substituting the expression $\frac{ds}{d\alpha}$ from (3) into (7), we obtain dependencies for finding coordinates *x* and *y* curve:

$$x = \frac{v^2}{g}\int \frac{\cos\alpha d\alpha}{a_{\text{tg}} - \cos\alpha} = \frac{a_{\text{тс}} v^2}{g}\int \frac{d\alpha}{a_{\text{tg}} - \cos\alpha} - \frac{v^2}{g}\alpha;$$
$$y = \frac{v^2}{g}\int \frac{\sin\alpha d\alpha}{a_{\text{tg}} - \cos\alpha} = \frac{v^2}{g}\ln(a_{\text{tg}} - \cos\alpha). \tag{8}$$

It can be seen from (8) that after integration the expression $y = y(\alpha)$ has a simple form, and the form for the coordinate $x = x(\alpha)$ reduces to integrals (4), so it breaks down into two dependencies for $a_{\text{ts}} > 1$ and $a_{\text{ts}} < 1$:

$$x=\frac{2a_{\text{tg}}v^2}{g\sqrt{a_{\text{тс}}^2-1}}\text{arctg}\sqrt{\frac{a_{\text{tg}}+1}{a_{\text{tg}}-1}}\text{tg}\frac{\alpha}{2}-\frac{v^2}{g}\alpha; \qquad (a>1)$$

$$x=\frac{a_{\text{tg}}v^2}{g\sqrt{1-a_{\text{tg}}^2}}\ln\frac{(1+a_{\text{tg}})\text{tg}\frac{\alpha}{2}-\sqrt{1-a_{\text{tg}}^2}}{(1+a_{\text{tg}})\text{tg}\frac{\alpha}{2}+\sqrt{1-a_{\text{tg}}^2}}-\frac{v^2}{g}\alpha. \qquad (a<1) \tag{9}$$

In expressions (8), (9), constant integrations are omitted, since they affect only the parallel transfer of the curve along the *Ox axes* and *Oy* .

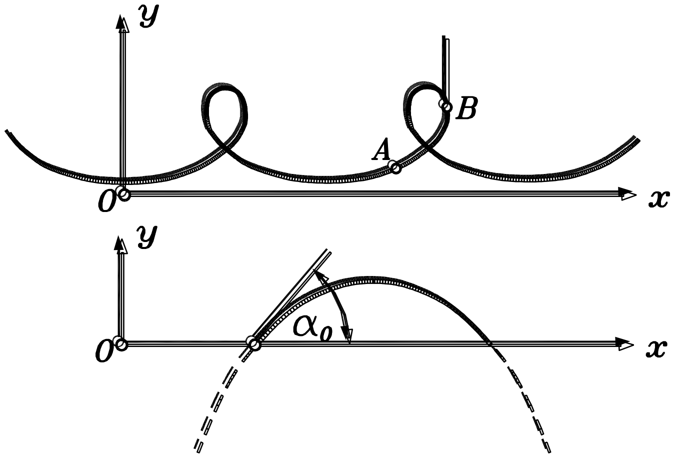

Fig. 2. Curves providing a constant pressure at a constant speed of particle movement:

a – a $_{\text{tg}}$ *=1.2; v = 3 m/s; b – a* $_{\text{ts}}$ *=0; v = 3 m/s.*

In fig. 2, *a*, *b* are plotted curves according to the equations $y = y(\alpha)$ from (8) and $x = x(\alpha)$ from (9) for $a_{\text{tg}} > 1$ and *and* $_{\text{tg}}$ *<1* .

Fig. 2, *a* shows the cross-sectional curve of the surface, the pressure on which at a given speed *v = 3 m/s is 1.2 times* greater than the weight of the particle. The section of the curve $\overset{\frown}{AB}$ can be considered as a possible profile of the cultivator's paw and stand.

Example. Taking the mass of a motorcyclist with a motorcycle as a material point, find the difference in height between the highest and lowest points of the curve at a speed of *v = 100 km/h = 27.8 m/s* and overloaded by *20 % (* $a_{\text{tg}} = 1.2$*).*

The lowest point will be at $\alpha = 0^o$, and the highest at $\alpha = 180^o$. So, according to the equation $y = y(\alpha)$ (8) we have:

$$\Delta y = y_{\alpha=180} - y_{\alpha=0} = \frac{v^2}{g}\ln\frac{a_{tg}+1}{a_{tg}-1} = \frac{27{,}8^2}{9{,}81}\ln\frac{1{,}2+1}{1{,}2-1} = 189(m).$$

If $a_{tg} < 1$, that is, the pressure on the surface should be less than the weight of the body, then such a reduction is possible due to the fact that the body will move along the outer side of the convex curve. Fig. 2, *b* shows a curve for $a_{tg} = 0$, that is, the pressure on it is zero. For a given speed *v*, such a curve exists for angle values α from a certain interval. It is practically impossible to use such a curve, since it does not act on the particle and can be considered as a limiting curve. We will explain what has been said on the following example. Let the curve (Fig. 2, *b*) be the profile of the bridge. Once the motorcyclist reaches the rated speed on the bridge, the pressure on the bridge will disappear, so he will not be able to maintain this speed any further due to the lack of friction. On the other hand, if the motorcyclist somehow manages to maintain the calculated speed (for example, due to jet thrust), then the trajectory of his movement will be determined by the curve of the bridge even in its absence.

2. Curves providing a constant traction force at a constant speed of particle movement.

We will assume that the surface on which the particle moves has a constant coefficient of friction *f*. In order for the particle to rise along the curve with a given constant speed *v* , the traction force $F_{tg} = const$ (Fig. 1) should balance the component of the weight force $mg \sin \alpha$ and the friction force F_{tg} where F_{tg} is determined from (1). Projecting the indicated forces onto the tangent $\bar{t}$ curve, we get:

$$mg\sin\alpha + f(mg\cos\alpha + mv^2k) = F_{tg}. \tag{10}$$

Equation (10) has a solution for $k = 0$, while $\alpha = const$, that is, we will have a straight line inclined at an angle α to the horizon. This is a well-known elementary example from theoretical mechanics. We will look for a curve that satisfies equation (10). At the same time, there will be a significant difference between the movement of a particle along straight and curved lines: in the first case, the speed can be arbitrary in magnitude, in the second - specific and dependent on the natural equation of the curve $k = k(s)$. Transforming equation (10) similarly to equation (1), we obtain:

$$\frac{ds}{d\alpha}=\frac{fv^2}{g(a_{tg}-\sin\alpha - f\cos\alpha)}, \qquad k=\frac{g}{fv^2}(a_{tg}-\sin\alpha - f\cos\alpha), \quad (11)$$

where the coefficient $a_{tg} = F_{tg} / mg$ shows what fraction of the weight of the particle is the traction force. We transform the expression in brackets of equations (11) as follows:

$$a_{тг}-(\sin\alpha+f\cos\alpha)=a_{tg}-\sqrt{1+f^2}\left(\frac{1}{\sqrt{1+f^2}}\sin\alpha+\frac{f}{\sqrt{1+f^2}}\cos\alpha\right). \quad (12)$$

Taking into account that $f = \mathrm{tg}\ \varphi$, where φ is the friction angle, expression (12) takes the form:

$$a_{тг}-\frac{1}{\cos\varphi}(\cos\varphi\sin\alpha+\sin\varphi\cos\alpha)=a_{tg}-\frac{1}{\cos\varphi}\sin(\alpha+\varphi). \quad (13)$$

Taking (13) into account, expressions (11) will be rewritten:

$$\frac{ds}{d\alpha}=\frac{v^2\sin\varphi}{g\left[a_{tg}\cos\varphi-\sin(\alpha+\varphi)\right]}; \qquad k=\frac{g}{v^2\sin\varphi}\left[a_{tg}\cos\varphi-\sin(\alpha+\varphi)\right]. \quad (14)$$

Comparing expressions (3) and (14), we see that they are similar. For a complete analogy, let's go from the sine of the variable angle in (14) to the cosine (at the same time, the integration will take place according to similar formulas):

$$\frac{ds}{d\alpha}=\frac{v^2\sin\varphi}{g(a_{tg}\cos\varphi-\cos\beta)}; \qquad k=\frac{g}{v^2\sin\varphi}(a_{tg}\cos\varphi-\cos\beta), \quad (15)$$

where $\beta = \alpha + \varphi - 90^0$. Let's find the parametric equations of curve (15) using formulas (7). We will integrate by the variable β, so the expressions for $\cos\alpha$ and $\sin\alpha$ will be written:

$$\begin{aligned}\cos\alpha &= \cos(\beta-\varphi+90^0) = -\sin(\beta-\varphi);\\ \sin\alpha &= \sin(\beta-\varphi+90^0) = \cos(\beta-\varphi).\end{aligned} \quad (16)$$

Substituting in (7) $\cos\alpha$ and $\sin\alpha$ from (16), $ds/d\alpha$ from (15), we get:

$$\frac{dx}{d\beta}=-\frac{v^2\sin\varphi\sin(\beta-\varphi)}{g(a_{tg}\cos\varphi-\cos\beta)}; \qquad \frac{dy}{d\beta}=\frac{v^2\sin\varphi\cos(\beta-\varphi)}{g(a_{tg}\cos\varphi-\cos\beta)}. \quad (17)$$

Let's bring expressions (17) to a form suitable for integration by expanding the sine and cosine of the angle difference:

$$x=\frac{v^2\sin^2\varphi}{g}\int\frac{\cos\beta d\beta}{a_{tg}\cos\varphi-\cos\beta}-\frac{v^2\sin\varphi\cos\varphi}{g}\int\frac{\sin\beta d\beta}{a_{tg}\cos\varphi-\cos\beta};$$
$$y=\frac{v^2\sin^2\varphi}{g}\int\frac{\sin\beta d\beta}{a_{tg}\cos\varphi-\cos\beta}+\frac{v^2\sin\varphi\cos\varphi}{g}\int\frac{\cos\beta d\beta}{a_{tg}\cos\varphi-\cos\beta}. \tag{18}$$

Now finding the equations of the curve is reduced to the integration of expressions (18), which include integrals similar to (8). So, we will again have two cases. For $a_{tg} > 1/\cos\varphi$, that is, for $F_{tg} > mg / \cos\varphi$, the integration of expressions (18) gives:

$$x=\frac{v^2\sin\varphi}{g}\left[\frac{a_{tg}\sin 2\varphi}{\sqrt{a_{tg}^2\cos^2\varphi-1}}\text{arctg}\frac{(a_{tg}\cos\varphi+1)\text{tg}\,\beta/2}{\sqrt{a_{tg}^2\cos^2\varphi-1}}-\cos\varphi\ln(a_{tg}\cos\varphi-\cos\beta)-\beta\sin\varphi\right];$$
$$x=\frac{v^2\sin\varphi}{g}\left[\frac{2a_{tg}\cos^2\varphi}{\sqrt{a_{tg}^2\cos^2\varphi-1}}\text{arctg}\frac{(a_{tg}\cos\varphi+1)\text{tg}\,\beta/2}{\sqrt{a_{tg}^2\cos^2\varphi-1}}+\sin\varphi\ln(a_{tg}\cos\varphi-\cos\beta)-\beta\cos\varphi\right], \tag{19}$$

where $\beta = \alpha + \varphi - 90^0$.

For $a_{tg}\cos\varphi < 1$, that is, for $F_{tg} < mg / \cos, \varphi$ after integrating expressions (18), we obtain:

$$x=-\frac{v^2\sin\varphi}{g}\left\{\ln A^{-\sin\varphi}\left[a_{tg}\cos\varphi-\sin(\alpha+\varphi)\right]^{\cos\varphi}+(\alpha+\varphi-90^0)\sin\varphi\right\};$$
$$y=\frac{v^2\sin\varphi}{g}\left\{\ln A^{\cos\varphi}\left[a_{tg}\cos\varphi-\sin(\alpha+\varphi)\right]^{\sin\varphi}-(\alpha+\varphi-90^0)\cos\varphi\right\}, \tag{20}$$

$$\text{де}\quad A=\left[\frac{(1+a_{tg}\cos\varphi)\text{tg}\left(\frac{\alpha+\varphi}{2}-45^0\right)-\sqrt{1-a_{tg}^2\cos^2\varphi}}{(1+a_{tg}\cos\varphi)\text{tg}\left(\frac{\alpha+\varphi}{2}-45^0\right)+\sqrt{1-a_{tg}^2\cos^2\varphi}}\right]^{\frac{a_{tg}\cos\varphi}{\sqrt{1-a_{tg}^2\cos^2\varphi}}}.$$

In particular, when $a_{tg} = 0$ (the traction force F_{tg} is zero), equation (20) is significantly simplified and takes the form:

$$x = -\frac{v^2 \sin\varphi}{g}\left\{\ln\left[-\sin(\alpha+\varphi)\right]^{\cos\varphi} + (\alpha+\varphi-90^0)\sin\varphi\right\};$$
$$y = \frac{v^2 \sin\varphi}{g}\left\{\ln\left[-\sin(\alpha+\varphi)\right]^{\sin\varphi} - (\alpha+\varphi-90^0)\cos\varphi\right\}. \qquad (21)$$

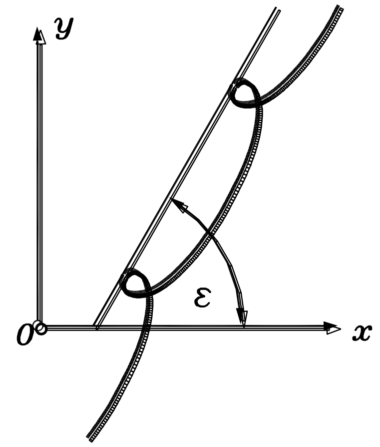

Fig. 3. The curve providing a constant traction force F $_{tg}$ at v = 3 m/s, f = 0.577, and tg = 1.2

Figure 3 shows a curve based on equations (19), for which the coefficient of friction is $f = 0.577$, i.e. $\varphi = \pi/6$. For this case, the inequality a_{tg} must hold cos$\varphi > 1$, that is *and* $_{tg} > 1/\cos\varphi$, otherwise the curve should be constructed according to equations (20). As can be seen from Fig. 3, the curve is periodic and inclined to the horizon at an angle ε. If a certain traction force is applied to a material point, which according to the value of a_{tg} should be greater than the force of gravity, then the point will move along the concave side of the curve upwards with a constant speed. When $a_{tg} = 0$ (that is, the traction force $F_{tg} = 0$), equation (21) gives the curve shown in Fig. 4. In this case, the material point moves down the curve due to the force of weight, which is balanced by the force of friction. The curve is divided into sections by points *A* and *B.* If we give a material particle at point *A* an initial speed *v* directed to the right, then the particle will move with this speed along the convex side of the curve, which over time gets closer and closer to a straight line inclined to the horizon at an angle of friction φ. If, at point *A,* the particle is given an initial speed *v* directed to the left, then it will also move further with this speed along a curve that will eventually approach a straight line, but already on the concave side. In this case, the arc

AB can be considered a casing that changes the direction of the particle during free flight. If there was no cover *AB* , then the particle would move along a parabola and with acceleration (without taking into account the resistance of the medium). The casing dampens the acceleration due to friction and keeps the speed constant. It can start at any point within the arc *AB* , depending on the direction of the particle's speed after it leaves the previous working body. If a particle falls from a certain height, it is possible to determine its speed at the end of the fall and for this speed calculate the curve for the casing, which should start at point *B* . Such a curve will ensure uniform movement of the particle further at the same speed.

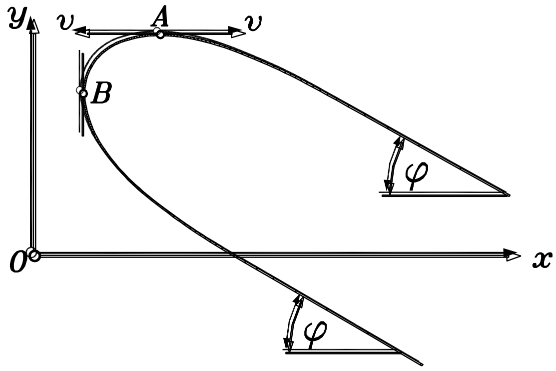

Fig. 4. A curve that ensures a constant speed in the absence of an active traction force (a_{tg} =0, f =0.577, v =3 m/s)

The equation of such a curve was obtained by Acad. P.M. Vasilenko in work [1] (p. 141, dependence (78) and p. 142, dependence (81)). These equations differ from equations (21), but if we move from them to the dependence $k = k(s)$, we will obtain the same natural equations:

$$k = \frac{2ge^s}{v^2 \sin\varphi (e^{2s} + 1)}. \tag{22}$$

This indicates that the specified equations in the work [1] and the obtained equation (21) are equations of the same curve. We also present natural equations corresponding to parametric equations (19) and (20):

$$k = \frac{g(a_{\text{tg}}^2 \cos^2 \varphi - 1)}{v^2 \sin\varphi \left(a_{\text{tg}} \cos\varphi + \cos \frac{g\sqrt{a_{\text{tg}}^2 \cos^2 \varphi - 1}}{v^2 \sin\varphi} s \right)} \text{ для } a_{\text{tg}} > \frac{1}{\cos\varphi};$$

$$k = \frac{2g(1 - a_{\text{tg}}^2 \cos^2 \varphi) e^{\sqrt{1 - a_{\text{tg}}^2 \cos^2 \varphi}\, s}}{v^2 \sin\varphi \left(e^{2\sqrt{1 - a_{\text{tg}}^2 \cos^2 \varphi}\, s} - 2a_{\text{tg}} \cos\varphi e^{\sqrt{1 - a_{\text{tg}}^2 \cos^2 \varphi}\, s} + 1 \right)} \text{ для } a_{\text{tg}} < \frac{1}{\cos\varphi}. \quad (23)$$

When $a_{\text{tg}} = 0$, the second equation (23) turns into equation (22).

Research results and their discussion. Comparing the natural equations of curves (5), which provide a constant pressure, with the natural equations of curves (23), which provide a constant thrust force, we can conclude that they are the same curves, only with different constant coefficients. Indeed, for $a_{\text{ts}} > 1$ and $a_{\text{tg}} > 1/\cos\varphi$ these equations can be reduced to the common form:

$$k = \frac{A^2 B}{\sqrt{A^2 + 1} + \cos(ABs)}, \quad (24)$$

where $A = \sqrt{a_{\text{tg}}^2 - 1}$ and $B = g / v_{\text{tg}}^2$ - for the constant pressure curve;

$A = \sqrt{a_{\text{tg}}^2 \cos^2 \varphi - 1}$ ahd $B = g / v_{\text{tg}}^2 \sin\varphi$ - for a constant thrust curve.

Having equated the coefficients *A* and *B* for the curves of constant pressure and constant thrust, we obtain the ratio between the constant values:

$$a_{\text{tc}} = a_{\text{tg}} \cos\varphi; \qquad v_{\text{tc}} = v_{\text{tg}} \sqrt{\sin\varphi}. \quad (25)$$

This means that a constant thrust curve can be a constant pressure curve and vice versa. In order for the curve of constant thrust (Fig. 3) to become a curve of constant pressure, it is necessary to turn it to a horizontal position (as shown in Fig. 2, a) and force the particle to move at a speed $v_{\text{tc}} = v_{\text{tg}} \sqrt{\sin\varphi}$. At the same time $F_{\text{tc}} = F_{\text{tg}} \cos\varphi$, the pressure force *will* be v_{ts} will be smaller than the traction force F_{tg} and the speed v_{tg} , at which the curve is a curve of constant traction.

Conclusions and perspectives. The equations are retrieved and the curves are constructed, which one provide constant thrust force or constant of pressure of a mass point driving on a curve from constant speed.

The curves will retain their properties only if the value of the calculated speed is strictly observed. This is explained by the fact that in the equations of the curves, the speed value is squared, so even a slight deviation from the calculated one will cause a significant deviation of the expected results.

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РОЗРАХУНОК ЦИЛІНДРИЧНОЇ ПОВЕРХНІ, ЩО ЗАБЕЗПЕЧУЄ СТАЛУ СИЛУ ТЯГИ АБО СТАЛУ ВЕЛИЧИНУ ТИСКУ МАТЕРІАЛЬНОЇ ЧАСТИНКИ, ЯКА РУХАЄТЬСЯ ПО НІЙ ІЗ ПОСТІЙНОЮ ШВИДКІСТЮ

С. Ф. Пилипака, А. В. Несвідомін

Анотація. *Відомі дослідження, в яких розглядається рух матеріальних частинок по гравітаційних поверхнях. Швидкість руху по кривій в таких випадках змінна. Проте в сільськогосподарських машинах можуть бути випадки, коли частинка рухається по поверхні із постійною швидкістю. У такому випадку на частинку, крім сили ваги, діє сила тяги.*

Мета дослідження - розрахунок циліндричної поверхні, що забезпечує сталу силу тяги або сталу величину тиску матеріальної частинки, яка рухається по ній із постійною швидкістю.

Були знайдені криві, при русі по яких із постійною швидкістю частинка чинитиме сталий тиск або активна сила тяги буде сталою.

Знайдено рівняння та побудовано криві, які забезпечують постійну силу тяги або постійну величину тиску матеріальної частки, що рухається по кривій із постійною швидкістю.

Ці криві зберігатимуть свої властивості тільки при точному дотриманні величини розрахункової швидкості. Це пояснюється тим, що в рівняннях кривих величина швидкості піднесена до квадрату, тому навіть незначне її відхилення від розрахункової викличе суттєве відхилення очікуваних результатів.

Ключові слова: ***матеріальна частинка, циліндрична поверхня, сила ваги, сила тяги, швидкість***