Key words: ***sugar beet crop, transportation, automobile semitrailer, semishuttle traffic, productivity***

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ANALYTICAL MODEL INSTALLATION Ground SPHERICAL DISK for definition of geometrical CHARACTERISTICS AND TECHNOLOGY

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Abstract.*Done analytical model settings spherical disks in the coordinate system of accepted traffic unit along the axis OY. For a given disk size and angles of attack and roll is determined by their position and the band treated soil. According to the agronomic requirements defined angles installations and grinding discs.*
Keywords: Tillager spherical disc, the direction of the unit, the equation of the surface of the disk, the installation angles

Formulation of the problem. Drive design parameters and viewing its settings affect the production process of the unit (kryshinnya rotation and tillage, stubble cutting, mixing them with soil, width disk, etc.). The distance between the wheels, their design parameters and angles of installation depends processed form profile strips of soil and altitude ridges. Each parameter has a certain impact on the process. For example, increasing the angle of attack leads to improved mixing soil with stubble remains, increasing the width disk, but may decrease the angular velocity of rotation by dragging the disc and, consequently, Pile mizhdyskovoho space soil and crop remains. With vertically mounted drives soil perceives mainly job strain and displacement rises at low altitude, causing not mixed with crop remains. In dismissing the plane of the disk blade from the vertical direction to the so-called mixing angle of heel is improving, but to a certain limit growth of this angle. Changing the design parameters of a drive (its diameter and the radius of the sphere) or angles of leading to changes in the shape profile of the treated strips. In this regard, it is advisable to have a mathematical model of the disk surface angle settings, in which the inherent structural and geometric settings and change each of which makes it possible to clearly define a profile of the treated strips to scale and optimize the drive position.

Analysis of recent research. Design and calculation of disk tillage tools thoroughly considered in the work [1] and other earlier publications [2, 3].

There is work devoted entirely to consideration of this issue [4-6].

The writings narrower focus examines various aspects of quality improvement tools such cultivation [7-9]. Prospects for further improvement and other disk tillage tools considered in work [10].

The purpose of research. Develop analytical model of spherical arrangement of disks in the spatial coordinate system for a given movement of the unit along one of the axes.

Results. Describe the initial position of the sphere of parametric equations, thus taking on the axis of rotation coordinate axis OX, which is parallel to the horizontal plane, ie, the surface of the field:

$$X_0 = R\cos u;\quad Y_0 = R\sin u \sin v;\quad Z_0 = R\sin u \cos v, \tag{1}$$

where: v and u - independent variable surface, and v - angle of the current point areas along the axis OX parallel (v = 0 ... 2π); u - the coordinate of this point arc along the meridian at which counting starts from the point of intersection of the axis OX surface areas.

The inner surface of the spherical disk design is characterized by two parameters - the diameter D and the radius of the sphere R (Fig. 1, a), which are interconnected relationship:

$$D = 2R\sin\sigma, \tag{2}$$

where: σ - half angle at the top of the sector AOB (Fig. 1 a).

It follows that the variable u in equation (1) varies u = 0 ... σ. Fig. 1 would equations (1) built compartment areas at R = 0,5 and σ = 36°.

Getting coordinates placed in the middle of which is the periphery of the disc.

With this arrangement, the disk angle of attack α and angle β from a vertical zero.

For orientation drive in position should parametric equation (1) change the way that they take into account his turn at specified angles α and β.

To use this turn comfortably sphere of radius (Fig. 2).

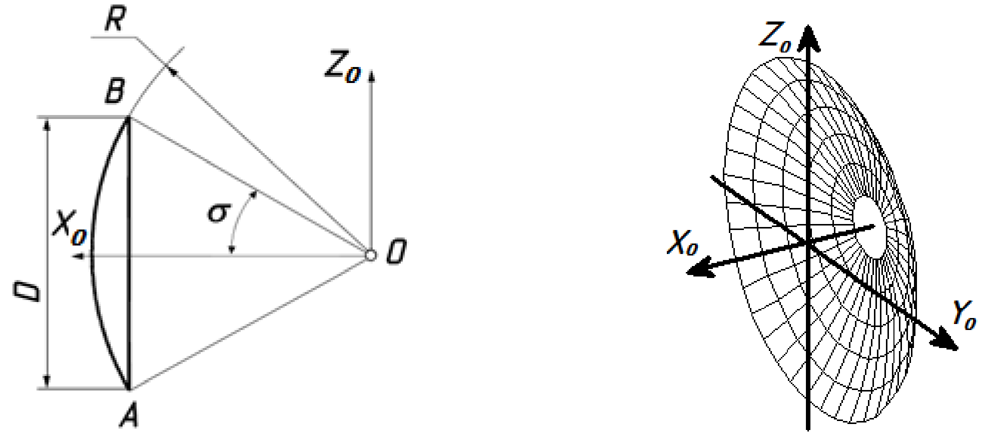

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Fig. 1. Scheme drive: - a) and its surface is based on equations (1) - b).

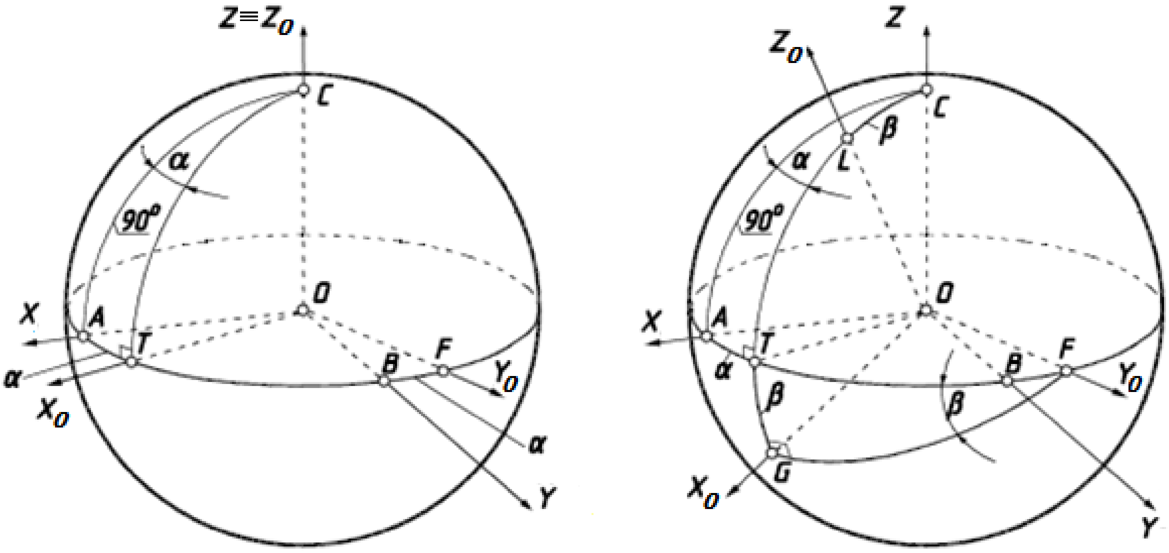

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Fig. 2. Scope of radius of a sequence of rotations of the coordinate system of the original position in the final OXYZ OX0Y0Z0 at angles of attack and roll α β: a) first made a turn around the axis OZ at an angle of attack α; b) a second rotation axis OY0 made to roll angle β.

In the initial position of the plane of the disk blade is in the vertical plane OY0Z0 (Fig. 1b), ie angles of attack α and β roll no. We place our system of coordinates with disk surface in the new system OXYZ, in relation to which we do turn drive. In the initial position of the axis of the same. The system will return to the OZ axis angle of attack α (Fig. 2a). Then formed rectangular spherical triangle SAT with a right angle at the top of the T, which we will need in subsequent calculations, and the system will take a new position OX0Y0Z0, whose axis passes through the T, F and C on the surface of a sphere. The second rotation axis OY0 feasible to roll angle β (Fig. 2b). This forms another rectangular spherical triangle with TGF right angle at the top G. coordinate system to the disk takes a final position OX0Y0Z0, whose axis passes through the G, F and L on the surface of the sphere.

The next stage - sproektsiyuvaty OX0Y0Z0 return the system along with the disk surface in a fixed system OXYZ. It comes down to finding the projections of individual segments OG, OF and OL, belonging axes OX0, OY0 and OZ0 (Fig. 2b), the fixed coordinate system, that should each of these segments sproektsiyuvaty three axes OX, OY and OZ. To do this we need to know the angles that form each segment with three axes. In this case it is convenient to use the obtained rectangular spherical triangles and spherical trigonometry formulas.

Proektsiyuvannya start of the segment OG. The segment OA on the axis OX by making two turns at angles α and β, consistently took the position that's OG (Fig. 2b). This spherical right triangle formed ATG with a right angle at the top of the T (hypotenuse AG in Figure 2, not shown). Mandatory condition for building a spherical triangle is the formation of its arcs of great circles (circles is formed by the intersection of a plane sphere that passes through its center). For these triangles is a characteristic that not only the top and sides and angles are measured. The top sets dihedral angle between the planes passing through the radius vector scope, and side - central angle between the radius vector. To find an unknown angle of a spherical triangle given by other formulas are appropriate. [11] Let us consider a spherical right triangle, as shown in Fig. 3 a.

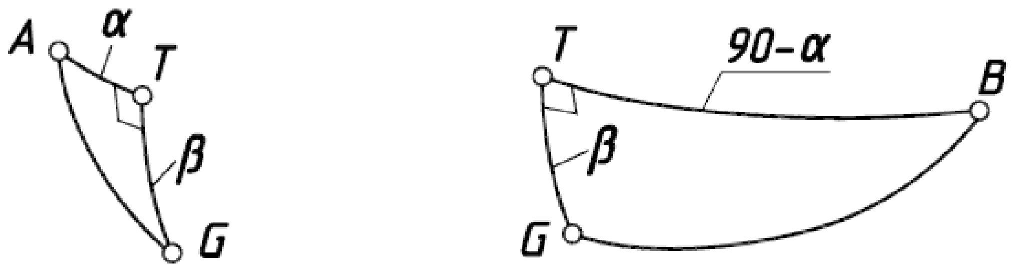

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Fig. 3. spherical right triangle formed by successive turning the system on OX0Y0Z0 angles of attack α and roll β (Fig. 2): a) the triangle to determine the angle between the axes OX0 and OX; b) the triangle to determine the angle between the axes OX0 and OY.

With it, we need to determine the angle between the axes OX0 and OX, which corresponds to an arc AG - hypotenuse of a right triangle spherical AGT. This angle is determined by the Pythagorean theorem to the rectangular spherical triangles under which the cosine of the hypotenuse is equal to the product of cosines legs. So we can write:

$$\cos AG = \cos\alpha\cos\beta \ . \qquad (3)$$

Angle between axes and OX0 OY (Fig. 2b) corresponds to the arc GV spherical triangle GVT (Fig. 3, B). Applying the Pythagorean theorem to the triangle GVT, we get:

$$\cos GB = \cos(90^0 - \alpha)\cos\beta = \sin\alpha\cos\beta\,. \qquad (4)$$

Finally, the angle between the axes OX0 OZ and SG meets the curve (Fig. 2b), which can record sum of two arcs: SG = ST + Tg = 900 + β. It will define the cosine of the desired angle:

$$\cos CG = \cos(90^0 + \beta) = -\sin\beta\,. \qquad (5)$$

Expressions (3), (4), (5) is directing cosines or projections OG unit vector belonging OX0 axis, the axis fixed coordinate system. Coordinate X0 current point on the drive after turning on angles α and β is written as projections on the axis of the fixed system OXYZ follows:

$$\{X_0\cos\alpha\cos\beta; \qquad X_0\sin\alpha\cos\beta; \qquad -X_0\sin\beta\}. \qquad (6)$$

Similarly, we can find the projection coordinates Y0 and Z0 point on the disc (ready to present results):

$$\{-Y_0\sin\alpha; \qquad Y_0\cos\alpha; \qquad 0\}. \qquad (7)$$

$$\{Z_0\cos\alpha\sin\beta; \qquad Z_0\sin\alpha\sin\beta; \qquad Z_0\cos\beta\}. \qquad (8)$$

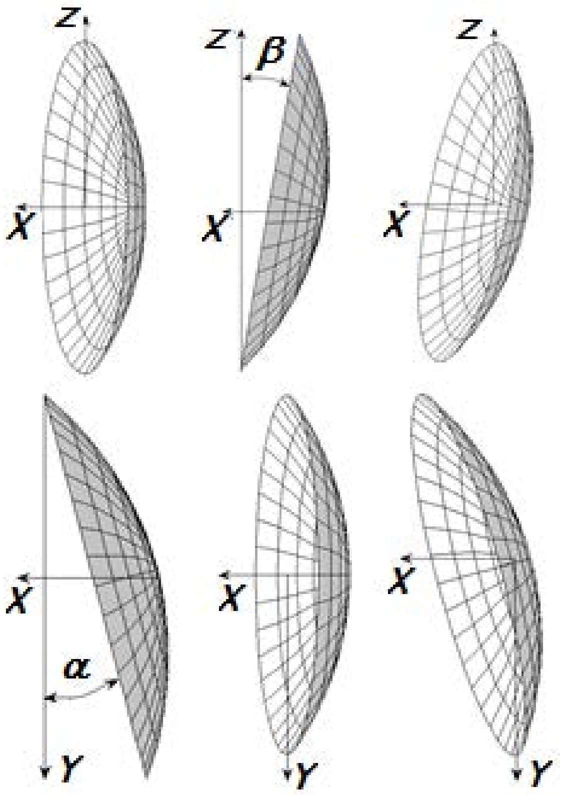
Longing projection (6), (7), (8) the relevant axis fixed coordinate system OXYZ, we get:

$$\begin{aligned} X &= X_0\cos\alpha\cos\beta - Y_0\sin\alpha + Z_0\cos\alpha\sin\beta; \\ Y &= X_0\sin\alpha\cos\beta + Y_0\cos\alpha + Z_0\sin\alpha\sin\beta; \\ Z &= -X_0\sin\beta + Z_0\cos\beta. \end{aligned} \qquad (9)$$

Substituting the coordinates of (1) the current point in the surface of the disk (9) and obtain parametric equations segment sphere rotated angles α and β with respect to the fixed coordinate system OXYZ:

$$\begin{aligned} X &= R(\cos u\cos\alpha\cos\beta - \sin u\sin v\sin\alpha + \sin u\cos v\cos\alpha\sin\beta); \\ Y &= R(\cos u\sin\alpha\cos\beta + \sin u\sin v\cos\alpha + \sin u\cos v\sin\alpha\sin\beta); \\ Z &= R(-\cos u\sin\beta + \sin u\cos v\cos\beta). \end{aligned} \qquad (10)$$

According to equation (10) can be built inside (working) surface of the disk as a segment of sphere returned to the set angles α and β. Fig. 4 in equations (10) constructed segment projections shown in Fig. 1b, with different combinations of angles α and β. For clarity, outdoor (not working) surface of the disk shown eclipses. Fig. 5 projections also built a group drive with a specified frequency offset along the axis OX. Front projection gives an idea of the shape of the cross-section of the treated strips of soil and the height of the ridges on the scale, as all construction carried out by given numerical values of the design parameters of the drive and angles α and β.



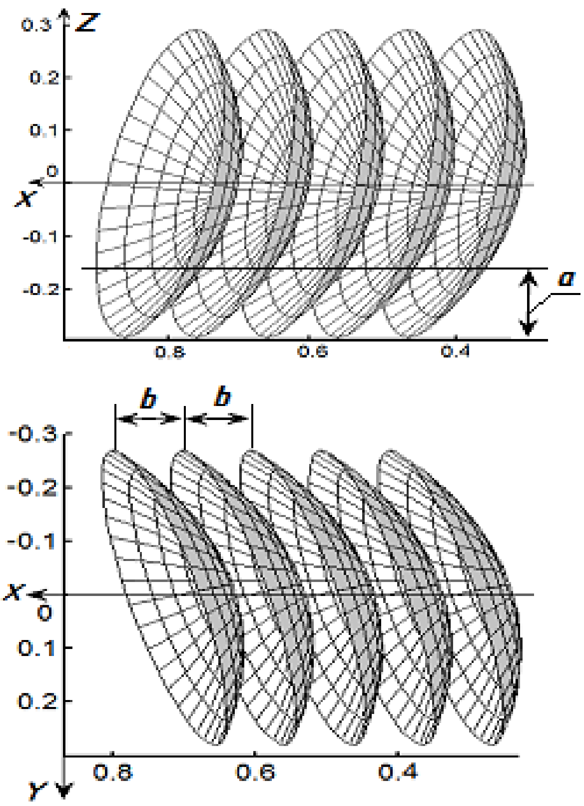


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Fig. 4. The inner surface of the disk as a sphere segment at R = 0,5 and σ = 360: a) α = 150, β = 00; b) α = 00, β = 100; in) α = 150, β = 100.

Fig. 5. Location discs at α = 150, β = 100 with displacement along the axis OX on the value of b = 0,1.

With this arrangement drives, as shown in Fig. 5, tool work unsatisfactory. At the back of the front projection shows a darkened disk. She will be based on the soil and prevent it zmynatyme hollow drive vykochennyu or promote it to the surface of the field. Therefore it is important to place the discs so that within the depths of the soil and the frontal projection was not the rear of the drive. At constant structural parameters of the drive can be achieved by increasing the angle of attack α. For example, increasing the angle of attack of α = α = 150 to 250, we rid ourselves within the depth of soil and back of the disk image on the front projection (Fig. 6) that does not interfere with the drive recess in the ground. By increasing the angle of attack decreases the height of ridges. This increases the distance b between the discs. If in Fig. 5 b = 0,1, after increasing angle of attack α from 150 to 250 b distance we have increased almost twice - up to 0.18. Fig. 5 horizontal projection wheels are on the line perpendicular to the motion unit. But they can be moved relative to neighboring certain amount along the axis OY, ie along the direction of the unit. Then the line of their arrangement forms a certain angle with the direction of the unit, but front projection does not change.

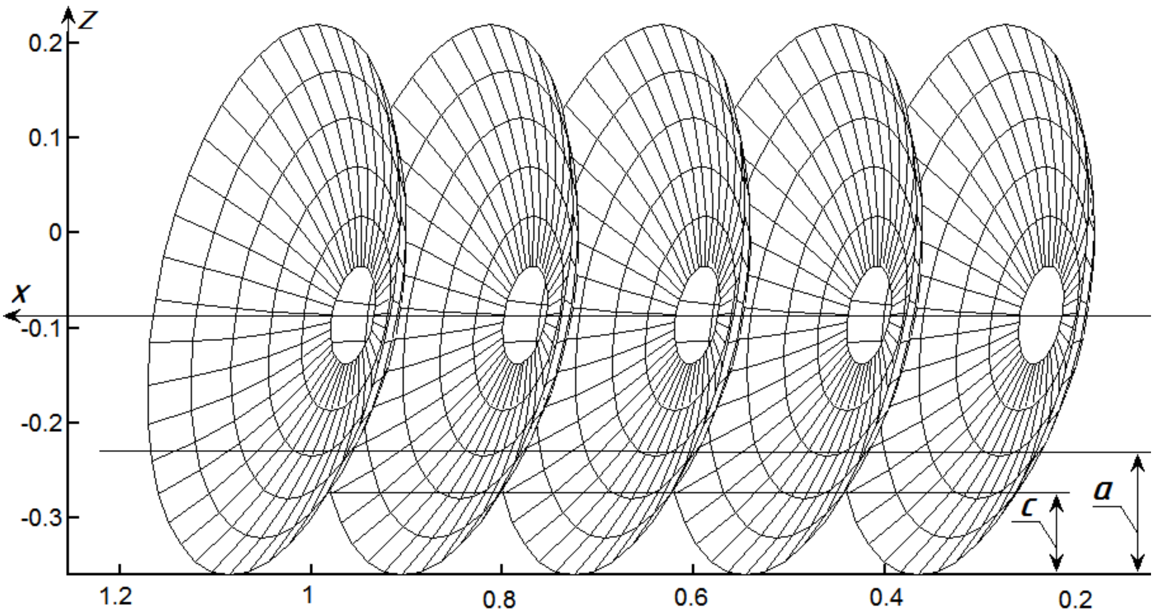

Fig. 6. Front projection discs set angles α = 250, β = 100 at b = 0,18.

Equation (10) can be found analytically dependent height of ridges on the design parameters of the drive parameters and their settings. If they instead substitute the variable u u = σ, these equations describe the edge of the disc - the circle that proektsiyuyetsya ellipse. The top of the ridge is determined by the intersection point of two adjacent ellipses in the frontal plane (Fig. 6). One of them opyshetsya on the frontal plane two equations (10) - at the top and bottom u = σ. The nearby ellipse opyshetsya same equations, and in the upper equation must add value bias b. When crossing two ellipses formed two points (bottom and top), the coordinates X and Z which are common. Joint intersection ellipse corresponding to a specific value of variable v, for example, v1, and the second - v2. Equating the lower and upper equation, we get a system of two equations with two unknown values v1 and v2. The software «Mathematica» gives the following solution (present only one value, since it will be enough):

$$v_1 = \mathrm{Arc}\cos\left(-\frac{\sqrt{4R^2\sin^2\alpha\sin^2\sigma - b^2}}{2R\sin\alpha\sin\sigma}\right). \quad (11)$$

Substituting the value of v1 (11) in the bottom of (10) when u = σ, we obtain Z coordinate crossing point (ridge top):

$$Z = -R\cos\sigma\sin\beta - \frac{\cos\beta}{2\sin\alpha}\sqrt{4R^2\sin^2\alpha\sin^2\sigma - b^2}. \quad (12)$$

Analytical shows that the lowest point of the ellipse corresponds to the value v = π. Substituting this value in the bottom of (10) when u = σ gives Z coordinate of the bottom groove:

$$Z = -R\sin(\beta + \sigma). \tag{13}$$

The difference coordinates Z (12) and (13) gives the analytical expression with ridge height:

$$c = \frac{\cos\beta}{2\sin\alpha}\left(2R\sin\alpha\sin\sigma - \sqrt{4R^2\sin^2\alpha\sin^2\sigma - b^2}\right). \tag{14}$$

In work [1] (p. 243, formula 1.381) are the expression of the ridge height of the vertical arrangement of disks, ie with β = 0. If this formula to replace the diameter D its expression from (2), and considering that our designations displacement between the discs b and labor [1] coordinated by the angle α, we get the result (14) of the unit instead of cos (β) . This is understandable, since the partial result is the total of (14) at β = 0. From (14) can be a complement to the findings in the work [1] that the increase in bank angle β leads to a reduction in the height of the ridge. In these figures represented drive surface of zero thickness. But the real drive has a thickness that it is limited to internal (working) and external (work any) spherical surfaces. Part of the volume between the surfaces of the disk is removed, as it should be sharpened at an angle δ (Fig. 7, a). Bevel surface, or surface grinding is a cone that has Generating inclined to the ground at an angle δ, and the bottom edge of the same blade.

Given the fact that the radius of the base of the cone is equal to D / 2 (Fig. 1, a), according to (2) it is Rsinσ. Parametric equations of cone generators inclined to the ground at an angle δ, be written:

$$\begin{aligned} X_K &= Ru\sin\sigma\,\mathrm{tg}\delta; \\ Y_K &= R\sin\sigma(1-u)\sin v; \\ Z_K &= R\sin\sigma(1-u)\cos v, \end{aligned} \tag{15}$$

where: v and u - independent variable surface, and v - angle of the current point of the cone axis OX (v = 0 ... 2π); u - rectilinear coordinate this point along the generatrix cone, which starts counting from its base.

Fig. 7, built to the inner surface of the disc and facet surfaces, and for clarity, they are removed from each other. Fig. 7, surface trim coupled with the outer surface of the drive surface chamfer and obscured. To install the trim surfaces in the operating position must use formulas (9), which instead should substitute equations scope cone equation (15):

$$\begin{aligned} X &= R\sin\sigma[u\mathrm{tg}\delta\cos\alpha\cos\beta - (1-u)\sin v\sin\alpha + (1-u)\cos v\cos\alpha\sin\beta]; \\ Y &= R\sin\sigma[u\mathrm{tg}\delta\sin\alpha\cos\beta + (1-u)\sin\cos\alpha + (1-u)\cos v\sin\alpha\sin\beta]; \\ Z &= R\sin\sigma[-u\mathrm{tg}\delta\sin\beta + (1-u)\cos v\cos\beta]. \end{aligned} \tag{16}$$

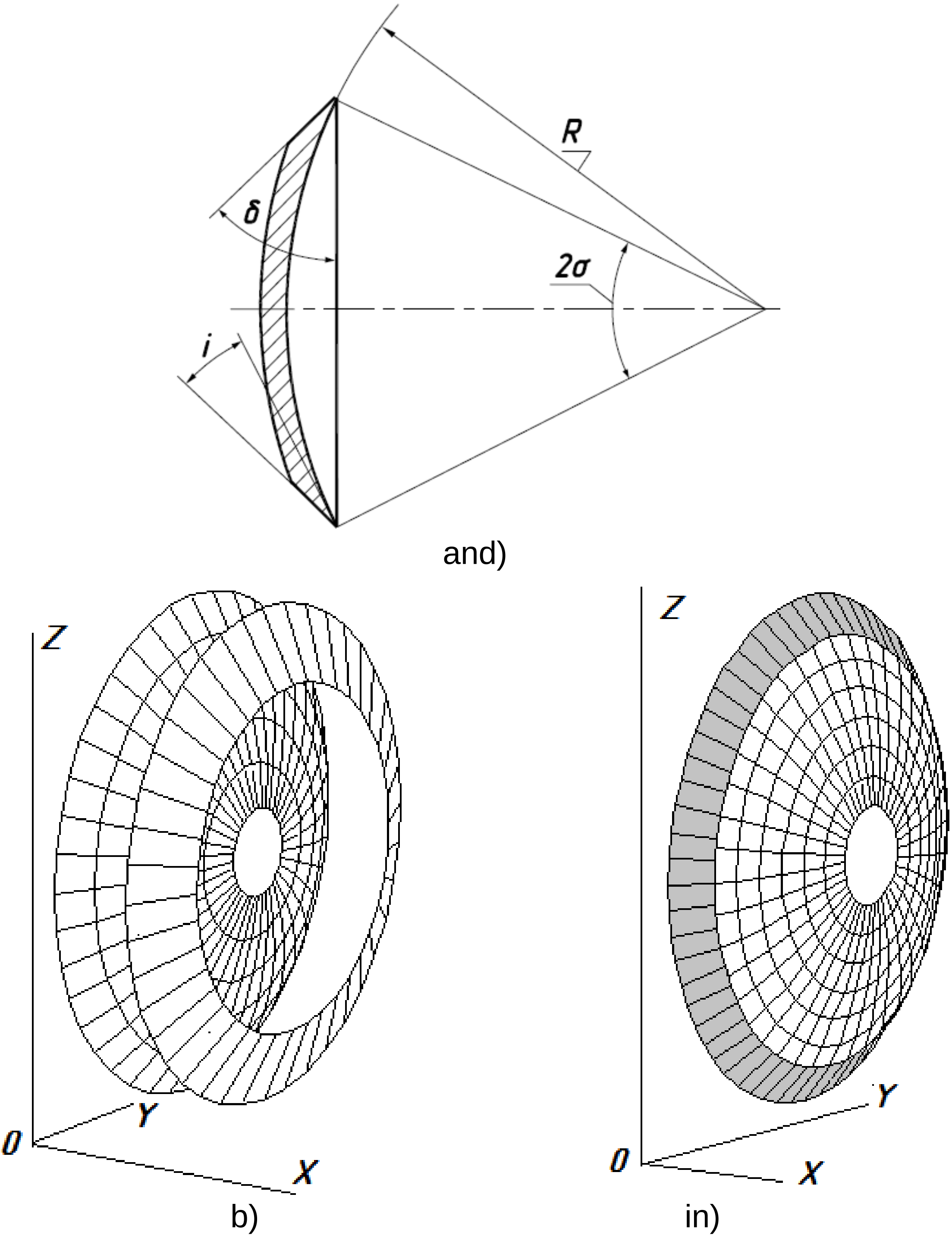

Fig. 7. The design bevel drive surface which is a cone with an angle of inclination δ generators to the base.

Working position chamfer surface is necessary in order to determine the sharpening angle δ. Design parameters drive R, σ and δ angles and its installation are in certain relationship.

On the one hand it is desirable to reduce the diameter D drive (that is, the angle σ) to better its entry into the soil, simultaneously reducing the radius R areas for better turning soil and mix it with plant remains, but it can lead to the surface trims will zmynaty ground and hinder immersion drive.

To avoid this, the angle δ sharpening should be taken such that it ensures the existence of so-called back corner in the area of the disk, ie the angle δ should take the lowest possible.

However, it is possible to reduce to a certain extent, as this angle decreases and aggravation (Fig. 7, a), which may not be less than the limit (corner sharpening and adopt within 12°... *25°*).

Angles α and β installation disc also affect the determination of the angle δ grinding at a given angle rear (3 ... 5°), Which prevents creasing soil surface trim just like the soil is crushing the back surface of the disk at the corners of his improper installation (Fig. 5, front projection).

Because of the limited amount of articles we finish the task of staging the choice of these parameters, which can be solved through Mathematical model of the working surface of the disk and its facets.

Conclusion. Developed a mathematical model of the spatial location of the spherical disks tillage implements a Cartesian coordinate system in which the axis OY is taken as the direction of the unit. This approach makes it possible to obtain images scale drive at any angles α and β of installation and visualize cross sectional profile of the treated strips. Calculation of the other parameters, including crest height of untreated soil, is based on an integrated spatial models, not on projections from the hand of their performance, as was done traditionally. The model enhances the operational design parameters selection disc with reference to the corners of his installation.

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Abstract.*Sostavleno analytycheskuyu model sferycheskyh installation disk in the Cartesian coordinate system with motion prynyatыm unit vdol axis OY. For zadannыm Size uhlam disk and roll attack and is determined Pos s s band obrabotannoy soil. In accordance with the requirements of ahrotehnycheskymy opredelyayutsya uhlы installation and sharpening disk.*

Keywords: sferycheskyy soil-cultivating disk unit movement direction, equation surface drive installation uhlы

Annotation.*It is made analytical model of installation of spherical disks in Cartesian coordinate system with the set movement of the unit along axis OY. On the set sizes of disks and angles of attack and rolls their position and a band of the cultivated soil is defined. According to agrotechnical requirements angles of installation and sharpening of disks are defined.*

Key words: spherical soil disc, direction of movement of unit, equation disk surface, corners of installation
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THEORETICAL SPECTRA OF SIGNAL CHU AND THEIR RELATIONSHIP WITH THE DURATION OF STRIKES

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Abstract.*Considered a classic and modern approaches to strikes in CHU diesel engines. The dependence of the width of the spectrum to determine the duration of collisions details. For modeling used mathematical package Mathcad 15.*

Keywords: shot, spectrum, amplitude, energy balance, plastic deformation, ultrasound

Formulation of the problem. Mechanical shock called a phenomenon that occurs in the collision of two bodies while accompanied by a complete or partial transfer of kinetic energy in the