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DESIGNING OF THE TUNNEL'S SURFACE

Designing of a surface of the tunnel on the set parameters.

The essence of transformation consists in the following. We take some points of a prototype *n*, then each of these points we subject to transformation *L*. Let's find set of points, smoothly having connected which we will receive a curve of an image n'. Thus the curve form n' depends on values of factors *m, k* of the prototype.

The tunnel surface is formed as a result of moving of a flat curve of the fourth order (section) on an axis of a quide curve.

Using graphic model of biquadratic transformation *L* we design the form of channel surfaces of the tunnel as follows:

1. Initial data for the decision of this problem are an axial line channel surfaces of the tunnel and laws of change of parameters of cross sections *a* and *b* (fig.1).

Each cross section n' of the tunnel is the curve of the fourth order received by using of biquadratic transformation *L*. Thus parameters *a* and *b* of each cross-section are defined from the formulas: $a = \gamma(l), b = \gamma(l)$ (1), where: *l* – distance from the beginning of the tunnel to considered cross-section.

We use the biquadratic transformation *L* set by the equations: $\begin{cases} x_1' = \sqrt{x_1^2 + x_2^2} \\ x_2^1 = \sqrt{x_2^2 - x_1^2} \end{cases}$ (2) where - x_1, x_2 co-ordinates of a point of a prototype; x_1', x_2' co-ordinates of a point of an image.

3. As a prototype we accept straight line of the general provisions *n* which equation looks like: $x_2 = kx_1 + m$ (3), where *k, m* – constant factors.

4. We define factors *k, m* of the equations (3). For this purpose we use properties of biquadratic transformation *L*: point – a prototype *B* and a point – an image B_2' of have identical height. Point B_2' is essay outlined point of section *n*. Therefore a point *B* of a prototype *n* has co-ordinates (fig.1): $x_{1_B} = 0$ (4) and $x_{2B} = a/2$ (5).

The point – a prototype *C* will be transformed to the points – images $C_1'=C_3'$ and $C_2'=C_4'$ which lay on axis Ox_1. Point C_1' has co-ordinates ($b+c; 0$). To the point C_1' corresponds a point *C* which there co-ordinates satisfy to a condition:

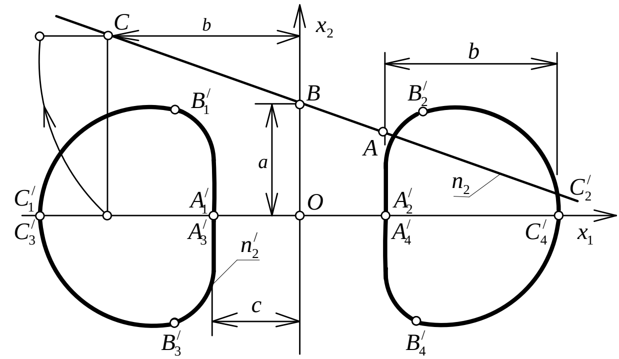

Fig.1

$$x_{1_C} = x_{2_C} \quad (6).$$

Let's define the co-ordinates of a point *C*. From a course of construction of point $C_1^{/}$ we can receive a following equation: $(b+c)^2 = x_{1_C}^2 + x_{2_C}^2$ (7), where: $c = a/2$.

Considering a condition (6), from the equation (7) we will receive $(b+c)^2 = 2x_{1_C}^2$, or $x_{1_C}^2 = (b+c)/2 = x_{2_C}^2$ (8).

The prototype *n* passes through the points *B* and *C*. Taking into account this we compose the following system of the equation:
$$\begin{cases} \dfrac{a}{2} = k \cdot 0 + m, \\ \dfrac{b+c}{\sqrt{2}} = k\dfrac{b+c}{\sqrt{2}} + m. \end{cases} \quad (9).$$

Having solved this system of the equations, we will receive: $m = a/2$ (10), $k = 1 - (a(2b+a))/2\sqrt{2}$ (11).

5. Subjecting a prototype *n* to biquadratic transformation *L*, we receive required section of the tunnel which satisfies to beforehand set conditions. The algebraic equation of this section looks like: $x_1^{/2} + x_2^{/2}(k^2+2) + (m/k)^2 = 0$ (12), where: *k*, *m* – the parameters of a prototype described by the equations (10) and (11).

The parametrical equation of section of the tunnel looks like:
$$\begin{cases} x_1' = \sqrt{x_1^2 + (kx_1+m)^2} \\ x_2' = \sqrt{(kx_1+m) - x_1^2} \end{cases} \quad (13),$$

where: x_1 – parameters $(b+c)^2/2 \le x_1 \le c/\sqrt{2}$; $m = a/2$, $k = 1 - a(2b = a)/2\sqrt{2}$.

6. Similarly, we design any demanded section of a considered surface of the tunnel (fig.2).

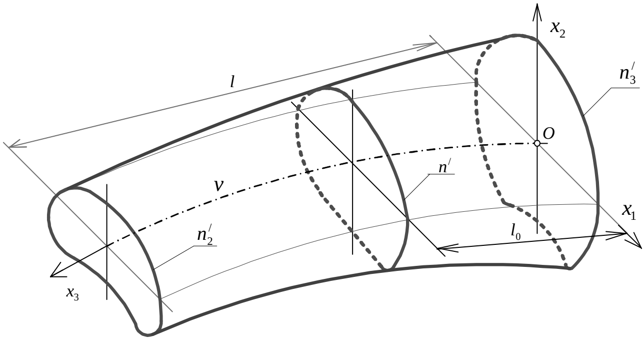

Fig.2

7. The equation of channel surfaces of the tunnel registers in a kind: $\begin{cases} x_3 = f(x_1), \\ x_2 = l_0. \end{cases}$ (14), where

$f(x_1)$ – the function describing a contour of cross section of the tunnel; l_o – distance from cross-section to the beginning of the tunnel, $x_3^{begin} \leq l_o \leq x_3^{end}$.