OPTIMIZATION OF STRUCTURAL PARAMETERS OF THE CROSS-SECTIONAL PROFILE OF RESERVE AND TECHNOLOGICAL LANES OF HIGHWAYS

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Abstract

The results of analytical optimization of the structural parameters of the profile of the cross-section of the reserve and technological lanes of highways by the methods of physical-dynamic simulation are given. On the basis of the analysis of the results of the numerical experiment, the optimal ratios of the width of the gas-dust protection belt to the total width of the reserve and technological lanes of motor roads with different intensity of motor transport flows were determined. It was established that the obtained results on the optimization of structural parameters of the profile of the cross-section of the reserve technological strips of highways allow to synchronize the collective movement of motor vehicles in the composition of motor transport streams, which ensures stabilization of modes of operation of motor vehicles, and therefore reduces the volumes of gas and dust emissions produced by motor transport streams.

Key words: road, ecological safety, landscape, reserve and technological lane of the highway.

Actuality of work. Optimization of the structural parameters of the cross-sectional profile of the reserve and technological lanes of highways in terms of minimizing the impact on the natural and man-made geoecosystem was performed on the basis of the method of simulating their physical and dynamic analog, which is implemented as a double-hinged beam with the length of the reserve and technological lane of the road in accordance with Fig. 1.

Material and results of research. The intensity of the traffic flow was simulated by the corresponding distributed load q, and the geometric coordinates of the beams' pillars corresponded to the coordinates of the obverse sides of the protective structures (in this case, the obverse sides of the gas and dust protection lanes of the highway). The plan for a complete factor simulation experiment therefore has the form:

$$X = \begin{vmatrix} M_1 & \Omega_1 \\ M_2 & \Omega_2 \\ \cdots & \cdots \\ M_n & \Omega_n \end{vmatrix}; \quad Y = \begin{vmatrix} y_1 \\ y_2 \\ \cdots \\ y_n \end{vmatrix}; \qquad (1)$$

where $Y = f(y_i)$ – corresponding response to the level of maximum influence of M_i (bending moment) and integral index Ω_i (work of motor transport with intensity q) of impact on the natural technogenic geoecosystem in general.

At the same time, the number of levels of variation of factors was $n = 6$, and the values of yi were determined, respectively, as (the corresponding designations are given in Fig. 2):

$$y_i = \frac{a_i - c_i}{2a_i} = \frac{b_i}{a_i}; \quad (2)$$

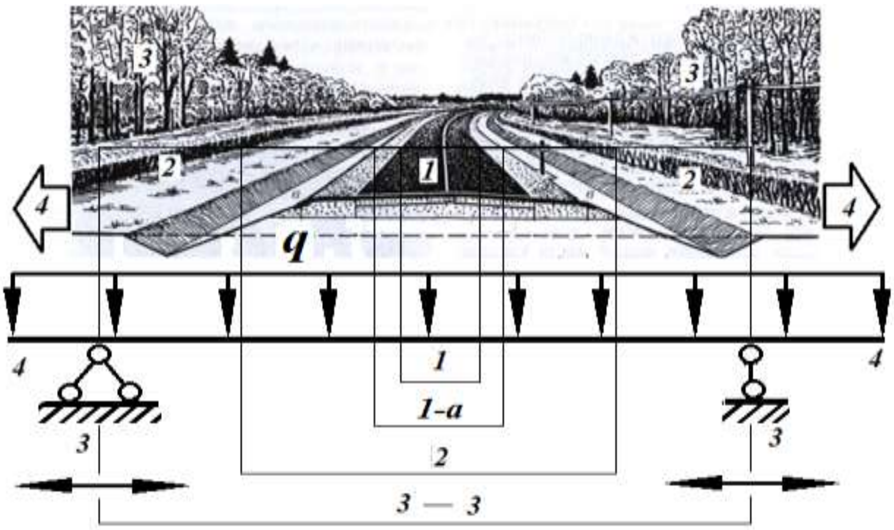


Fig.1 The zoning of the profile of the cross-sectional section of the highway: 1 - the roadway; 1st - earthly canvas; 2 - reserve technology strip; 3 - the obverse side gas-dust protection forest bands; 4 - lane of road impact

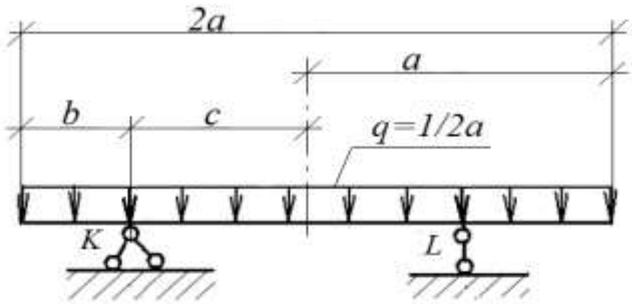


Fig.2. The block diagram of the simulation experiment

Thus, the results of a numerical experiment in accordance with the plan (1) can be represented as:

$$y_i = \frac{b_i}{a_i} = \varphi(M_i; \Omega_i) \tag{3}$$

The study (3) on the extremum allows us to establish the optimal ratio $\left(\frac{b}{a}\right)_{opt} = \langle y_i \rangle|_{M_{min}\Omega_{min}}$ and taking into account the requirements of the GBN B.2.3-218-007: 2012 "Transport facilities. Ecological requirements for highways. Designing "to establish eco-rational dimensions of the roadway, earthwork, reserve and technological strip, protective structures (in particular, the cross-sectional dimensions of the gas-dust protection forest bands), to specify the size of the lane of the road of the relevant category.

The results of the numerical experiment according to the plan (1) are given in Table 1. The study of the results of a numerical experiment on an extremum (Fig. 3) makes it possible to establish, in particular, the optimal ratio of the width of the gas-dust protection forest strip to the width of the reserve and technological lane of the highway in the form:

$$\left(\frac{b}{2a}\right)_{opt} = \langle y_i \rangle|_{M_{min}\Omega_{min}} = 0{,}333 \tag{4}$$

where b - the width of the gas-dust protection forest belt, *m*;

a - the width of the reserve and technological lane of the highway, *m*.

Consequently, the results of the performed numerical experiment can clarify the basic structural parameters of the transverse profile of the constituent elements of the reserve and technological lanes of motor roads of the corresponding categories (Table 2). At the same time, the width b (Fig. 2) of protective structures in the form of geochemical barriers (including gas-dust protection forest bands) in the reserve and technological lanes of highways was determined by the formula:

$$b = \frac{2 \cdot a - (n \cdot h + 2 \cdot z + f)}{2} \tag{5}$$

where h - width (*m*) of the lane, chosen according to DBN V.2.3-4: 2007;

n - the number of lanes for the road of the corresponding category for the DBN V.2.3-4: 2007;

z - width (m) of the curb according to DBN V.2.3-4: 2007;

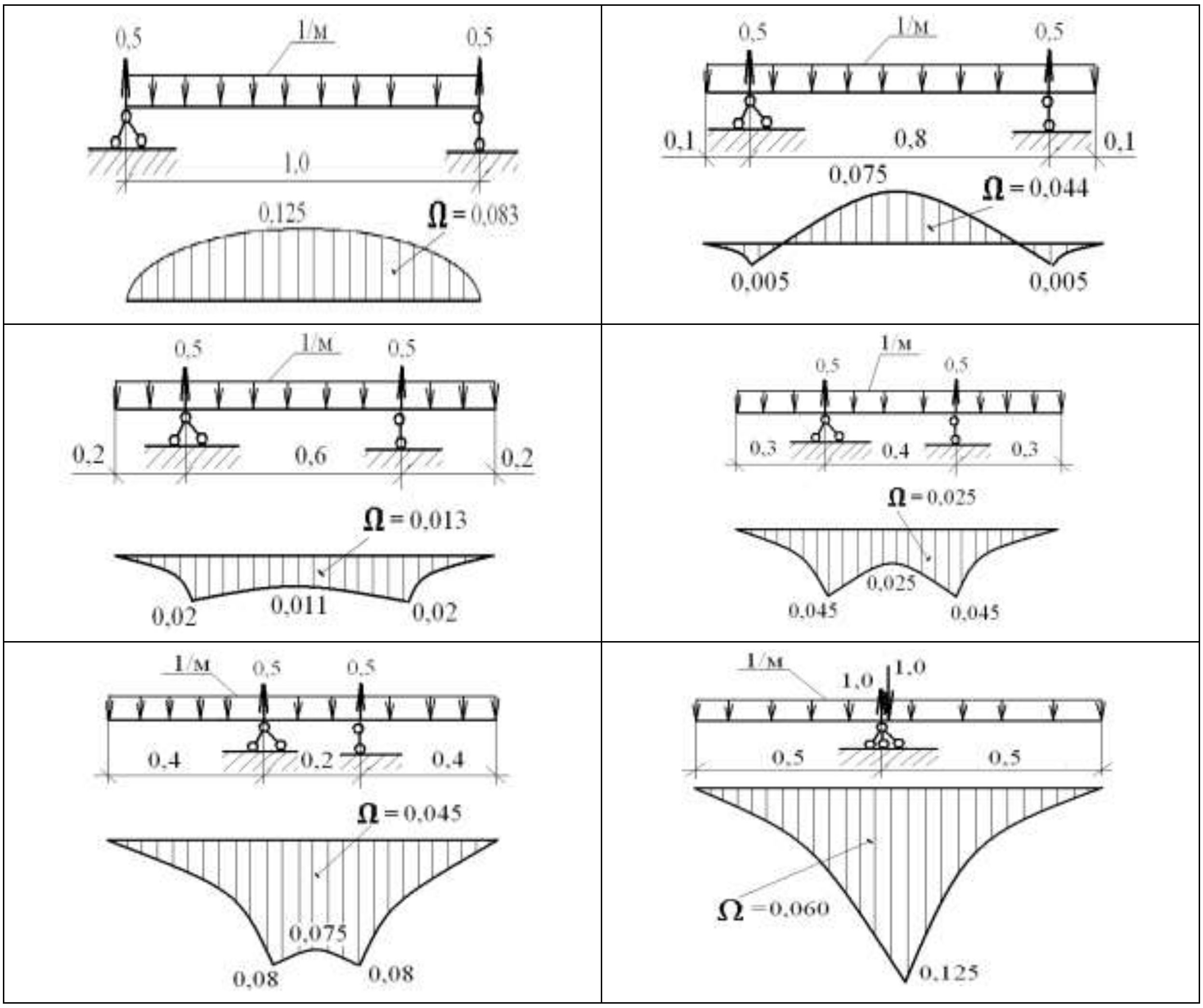
f - width (m) of the dividing strip for DBN V.2.3-4: 2007;

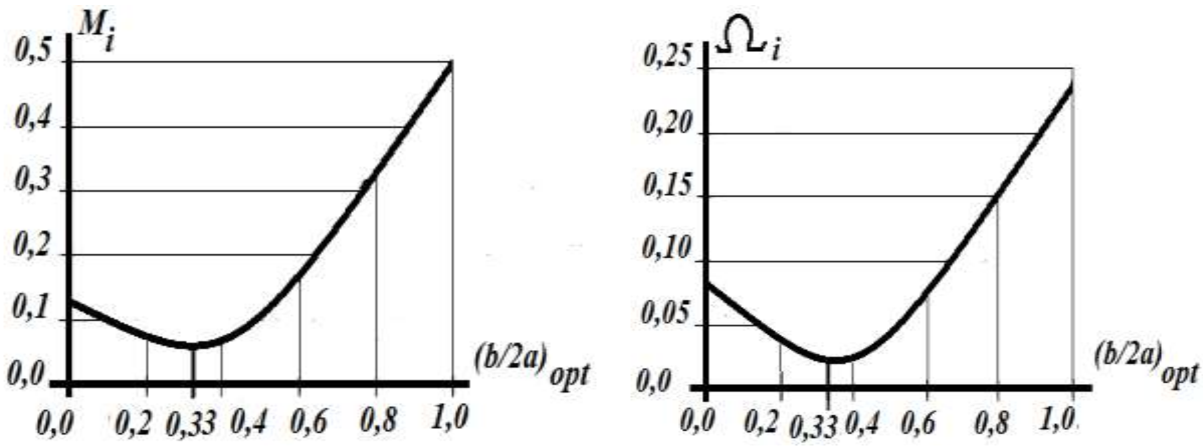
a - topologically grounded size (m) of the reserve-technological band (width of the road zone), which is:

- for highways of the category 1-a, 1-b – *2a = 104 m*;
- for motor roads of category 2 – *2a = 68 m*;
- for motor roads of category 3 – *2a = 45 m*.

Table 1

Results of a numerical simulation experiment
by the method of physic-dynamic analogies





а *б*

Fig. 3. Investigations on the extremum of functions:
$a - \left(\frac{b}{2a}\right)_{opt} = \langle y_i, z_i \rangle|_{M_{min}}$; $б - \left(\frac{b}{2a}\right)_{opt} = \langle y_i, z_i \rangle|_{\Omega_{min}}$

Table 2

Parameters of the transverse profile of the road zone highways

Road category (DBN V.2.3-4: 2007)	1a, 1б	2	3
Width of the reserve technological band (road zone) *2a, m*	104	68	45
The width of the roadway *h, m* (DBN V.2.3-4: 2007)	22,5	7,5	7,0
Width of the road *z, m* (DBN V.2.3-4: 2007)	12,0	12,0	6,0
The width of the separate lane *f, m* (DBN V.2.3-4: 2007)	5,0	-	-
Width of protective geochemical barriers (gas-dust protection forest bands) *b, m*	32,25	24,25	16,0

Conclusion. The optimization of structural parameters of the cross-sectional profile of the reserve and technological lanes of motor roads allows to synchronize the collective movement of motor vehicles in the composition of traffic flows, which causes the stabilization of the operating modes of engines, and therefore reduces the volumes of gas and dust emissions produced by motor transport streams.

References

1. Sheludchenko, B. A. (2014). Vstup do konstruiuvannia pryrodno-tekhnohennykh heoekosystem (landshaftno-terytorialnyi aspekt) [Construction of natural and technogenic geo-ecosystems in brief (landscape and territory aspect)]. Kamianets-Podilskyi, SAIUP. [in Ukrainian].
2. Sheludchenko, L. S. (2015). Rozroblennya konstruktsiy hazo-pylozakhysnykh lisosmuh avtodorozhn′oyi merezhi [Development of constructions of gas-dust protection forest roads of the road network]. Kamianets-Podilskyi, SAIUP. [in Ukrainian].