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# THE STUDY OF THE ARRANGEMENT OF WORKING ELEMENTS FOR HOMOGENEOUS FROZEN ENVIRONMENTS FRACTURE

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**Abstract:** Experimental researches of the rational system of wedge-shaped destructive elements placement are expounded. The change of energy capacity of the ice layer destruction process is determined and experimentally grounded and the estimation of quality of road surface cleaning is given depending on placing of indents on the working body.
**Keywords:** agriculture, homogeneous frozen environment, crack, destruction, placement of wedge-shaped destructive elements, technological module, system of cracks

## 1. INTRODUCTION

The development of agriculture in the country provides field work in the winter, which allows harvesting. Therefore, it is necessary to have the proper technology to ensure the capacity of equipment to maintain all roads in a clean state for travel. The existing technologies of removing ice formations which appeared on the surface of road pavement, in particular the application of salts in agriculture are not effective enough because they cause corrosion of metallic surfaces, negatively influence road pavement, tires of cars, getting into soil or onto the wayside vegetation.

For this purpose, it is expedient to apply working equipment which would provide cleaning of road pavement without its damage and without contamination of the environment. Until recently, the development of their design has been mostly aimed at diminishing hauling resistance and to a lesser extent – at achieving high-quality operation indices and road pavement cleaning. According to the existing technologies, the required quality of road pavement cleaning is obtained with the utilization of combination of a few types of treatment which result in additional energy consumption [5,2].

## 2. MATERIAL AND METHOD

Despite the rapid growth of various methods for the development of homogeneous frozen media nowadays, the mechanical method of their destruction is considered to be the most effective which is performed by means of static and dynamic means of mechanization. A comparative analysis of methods for the development of homogeneous frozen media shows that more than 75% of work volume is performed by this method. As well as the resistance of homogeneous frozen media to fracture during the cleavage changes is very significant at small time intervals.

Analysis of the application of dynamic fracture shows its frequent use for homogeneous frozen media. The choice of the method of destruction is determined by the energy intensity of the process for the development of homogeneous frozen media.

Researches have shown that the energy intensity of the development of homogeneous frozen media by machines depends not only on the physical and mechanical properties, but also on the design of the working parts used to perform the work. The dominant amount of the total resistance to development is accounted by the frontal surfaces of the cutting working bodies of machines that include the tips of the teeth. Therefore, in order to reduce the strength of resistances to the development of homogeneous frozen media, it is very important to choose the optimal configuration of the working elements and the parameters of their cutting edges. The extensive use of machines necessitates the manufacture of tooth tips of various configurations. At the same time practical experience in the development of homogeneous frozen media is mainly taken into account.

The development of homogeneous frozen media essentially depends not only on the initial parameters of the working parts, but also on their changes in the development process. Investigations show that the efficiency of development falls sharply because of blunting of working parts as a result of abrasive wear. In some cases, the operating parts are wearing out to the limit values for 2-4 shifts of operation.

Reducing the wear rate of the working bodies will significantly improve the productivity of machines and the efficiency of their work. Improved efficiency as an integral indicator of the process of development of homogeneous frozen environments by the working bodies of machines is characterized not only by their high wearing resistance, but also by the energy efficiency of the development of homogeneous frozen media.

Therefore, there is a need to work out a methodology for determining the optimal geometric parameters and configuration of the working parts of machines, in particular their working surfaces that are directly involved in the destruction of homogeneous frozen media. This methodology should take into consideration the spatial and dynamic nature of the process of developing homogeneous frozen media, their physical and mechanical properties and development modes. Among the works on the study of the destruction of homogeneous frozen media, can be defined the works of the following scientists: *V.P. Goriachkin, N.G. Dombrovskyi, A.D. Dalin, A.N. Zelenin, I.Ya. Aizenshtok, V.D. Abezhauz, G.I. Veselov, Yu.A. Vetrov, D.I. Fedorov, K.A. Artemeva, V.I. Balovnev, I.P. Kerov, I.A. Nedorezov, E.I. Berestov, A.S. Slusareva, V.L. Baladinskyi, A.M.E. Dinglinger, I. Ratier, V. Zene* and *M. Nichols* [10].
The use of known theories for research purposes is associated with the difficulties that arise when obtaining the necessary physico and mechanical indicators, a wide range of changes in conditions, the complexity of the existing dependencies for determining the values of the resistance forces. In majority of works. It is necessary to take into account the geometric parameters, the configuration of the working elements in calculating the values of the resistance forces for the development of homogeneous frozen media.
Effecting on ice with dynamic loading of high amplitude but low frequency results in his instantaneous fragile destruction under the action of tension waves. The prerequisite of tension waves formation and their distribution in the environment under dynamic loadings, the influence on the destruction of material are considered in the monographs of the well-known scientists: *N.A. Alekseev, D.D. Barkan, L.I. Baron, V.L. Baladinsky, S.S. Grigoryan* and many others. The researches of physical and mechanical properties of ice and its destruction peculiarities have been performed by *G.L.Karaban, A.N. Zelenin, V.N. Denisov, L.S. Mnukhin, V.V. Bogorodsky, V.V. Laurel, K.F. Voytkovsky* etc. In the course of research it has been elucidated that the ice formed on road pavements of streets and sidewalks has an obviously expressed chaotic texture formation and the rate of its freezing up with road pavement depends on a series of factors, primarily on the state of road pavement surface [1,2,6]. In this connection it is an urgent task nowadays to develop highly efficient working bodies for ice removal, which would allow to improve the quality indices of road pavement cleaning without its damage grounding on the consideration of different formation terms.
The efficiency of an icebreaker operation substantially depends on placement of indents in the technological module, which form a system of destroying cracks on the ice surface. Therefore, while choosing the rational placement of contiguous destructive elements on a working body, it is possible to reduce the energy capacity of destruction process, to increase the area of destruction and decrease the size of fractions of the split off ice to provide necessary cleaning quality of road pavement.
Consequently, in order to provide high-quality operation of working equipment, it is necessary to create such a strained state in an ice array, so that to promote the distribution of destructive cracks down to the surface of road pavement. [3] Thus, the distance between the contiguous destructive elements must provide the mutual overlapping of the fields of their strained states that will enable to ensure the complete destruction of ice formations layer on the pavement.
As an object of the research there has been used a hydroimpulsive working body, the shocking plate of which is equipped with indents having appropriate geometrical parameters together with the brush for clearing from ice formation remains.

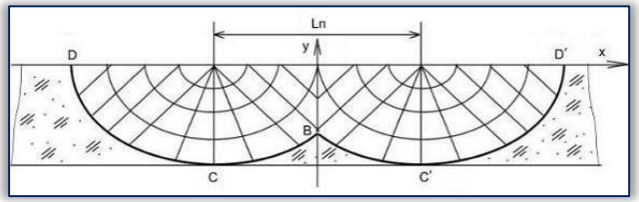

Figure 1 - Schemes of overlapping zones of stress state

Workings indents are accommodated in two parallel rows, in a chess order with the mutual overlapping of the destruction area (figure 2) perpendicular to the direction of icebreaker motion with the united front of cracks development.
It should be noted that with the implementation of the working body into the working environment with opened lateral walls, the blasted area is increased due to the appearance of cracks which go out on a lateral surface. In this case, the optimum value of shoulder of splitting off the size of which can be obtained under the condition of minimum energy necessary for the formation of splitting off cracks, serves as a determinative of the process.
Consequently, if to dispose an instrument nearby earlier created small hole of splitting off before a subsequent blow, the latter playing the role of an additional free surface, though of limited size; however the breakage is performed jointly.
The purpose of the experiment is the verification of analytical dependences and findings for the substantiation of parameters of splitting off and placing of indents for the destruction of an ice layer. The tests have been carried out on the laboratory installation presented in figures 2 and 3.

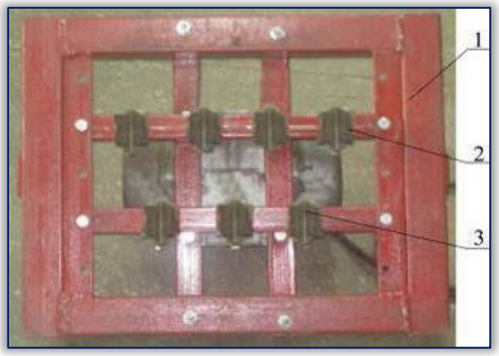


Figure 2 - Laboratory installation for the research of wedge-shaped destructive elements placed on the shocking plate: 1 – a frame of working body. 2 – the indents of the first row. 3 – the indents of the second row.

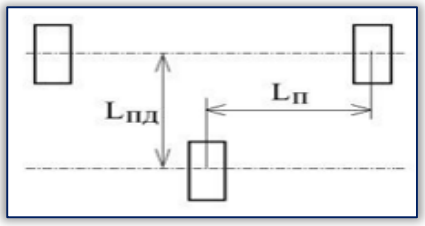


Figure 3 - Chart of wedge-shaped destructive elements placed in two parallel rows in a chess order

After conducting the experimental researches on a laboratory stand, it was performed the detecting of the influence of wedge-shaped destructive elements placing order on the peculiarities of the process: of operation *A*. of energy capacity $q_A$ of destruction process and index of cleaning quality of road pavement – the data have been obtained by which graphic dependences have been designed; this analysis allowed to define the basic particularities of wedge-shaped destructive elements interaction with the environment.

During conducting the experiment for creating high-quality picture, photographing was being performed. That has allowed to create a photogram presented in figure 4.


Figure 4 - Photogram of ice destruction process

As a result of experimental researches the dependences for placing of wedge-shaped destructive elements on the working body have been obtained, while removing ice formations from the surface of road pavement at the angle of an indent sharpening $2\alpha$=27°.

As a result of PFE was obtained a regression equation. It was introduced the regression equation in natural scale after which its decoding was got:

$$q = 65{,}36 - 18{,}67 \cdot L_{П} - 1{,}34 \cdot L_{ПД} - 5{,}42 \cdot H + 2{,}07 \cdot L_{П} \cdot L_{ПД} - \\ - 4{,}74 \cdot L_{П} \cdot H + 1{,}29 \cdot L_{ПД} \cdot H + 2{,}13 \cdot L_{П}^2 - 0{,}86 \cdot L_{ПД}^2 - 1{,}12 \cdot H^2 \quad (1)$$

$$k_{Я} = 1{,}021 - 0{,}029 \cdot L_{П} + 0{,}0003 \cdot L_{ПД} - 0{,}0011 \cdot H + 0{,}0015 \cdot L_{П} \cdot L_{ПД} - \\ + 0{,}0011 \cdot L_{П} \cdot H + 0{,}0002 \cdot L_{ПД} \cdot H - 0{,}0012 \cdot L_{П}^2 + 0{,}0004 \cdot L_{ПД}^2 - 0{,}0002 \cdot H^2 \quad (2)$$

The dependence of energy capacity process indices and quality of road pavement cleaning on the distance between the nearby wedge-shaped destructive elements at different thickness of ice layer *H* is resulted in figure 5 – 7.

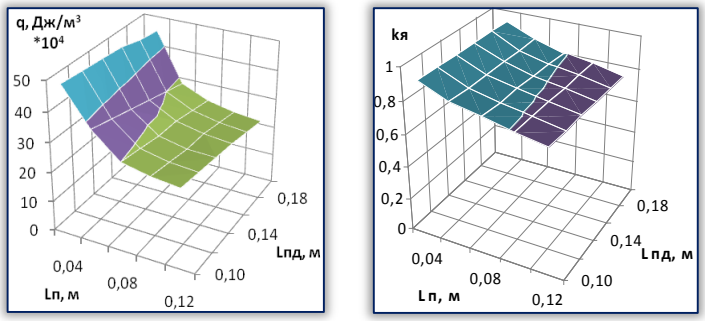


Figure 5 - Dependence of specific energy of destruction and the quality of road pavement cleaning on the distance between contiguous destructive elements at *H* = 0.06 m

## 3. CONCLUSION

In the course of experimental researches it has been determined (figure 5–7) that the energy capacity of the process diminishes proportionally with the growth of the distance between destructive elements and the quality of road pavement cleaning diminishes with the increase of the distance between contiguous destructive elements (figure 5–7). The performed experimental researches have enabled

to select the rational parameters of wedge-shaped destructive elements placement on a working body for the removal of ice formations which will satisfy minimum energy capacity at the set index of the quality of road pavement cleaning.

As a result of studies, there were found the rational placement options of destructive elements on your body to remove ice formations $L_{ПД}$ = 80–100 mm. $L_{П}$ =100–150 mm aspect $L_{П} / L_{ПД}$ = 0.7-0.8 with minimum power consumption for a given indicator as cleaning coating $k_{я}$ = 0.85-0.90.

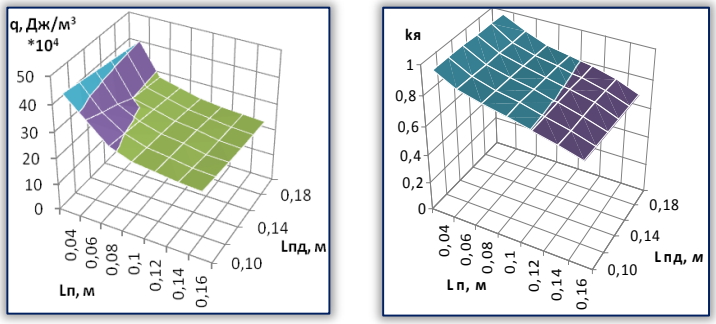


Figure 6 - Dependence of specific energy of destruction and the quality of road pavement cleaning on the distance between contiguous destructive elements at H = 0.08 m

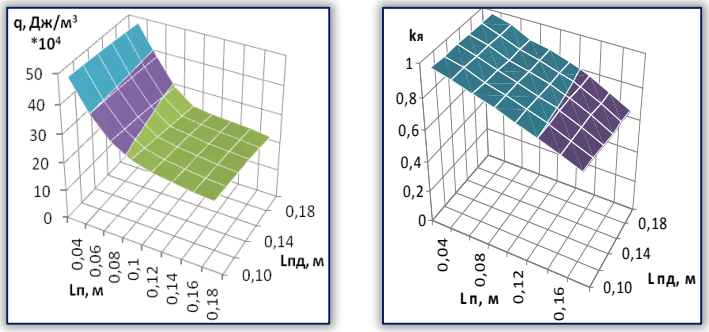


Figure 7 - Dependence of specific energy of destruction and the quality of road pavement cleaning on the distance between contiguous destructive elements at H = 0.10 m

**Note:** This paper is based on the paper presented at ISB-INMA TEH' 2017 International Symposium (Agricultural and Mechanical Engineering), organized by University "POLITEHNICA" of Bucharest – Faculty of Biotechnical Systems Engineering, National Institute of Research-Development for Machines and Installations Designed to Agriculture and Food Industry – INMA Bucharest, Scientific Research and Technological Development in Plant Protection Institute (ICDPP), National Institute for Research and Development for Industrial Ecology – INCD ECOIND, Research and Development Institute for Processing and Marketing of the Horticultural Products "HORTING" and Hydraulics, Pneumatics Research Institute INOE 2000 IHP, University of Agronomic Sciences and Veterinary Medicine of Bucharest (UASVMB) – Faculty of Horticulture and Romanian Society of Horticulture (SRH), in Bucharest, ROMANIA, between 26 – 28 October, 2017.

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