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THE INFLUENCE OF VARIOUS FACTORS ON THE DEGREE OF COMPACTION OF THE MATERIAL WITH A VIBRATING PLATE WITH A SMOOTH SURFACE

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In the process of researching vibrating plates designed for compaction of building materials, the problem of studying the shape of the working body and its influence on different types of compacted material can be highlighted. The study of this aspect is an important stage in the further development of vibration technology, as it allows to improve the designs of machines and increase the quality of technological operations [1, 2]. The key direction of research is the analysis of the interaction of the working body of the vibrating plate with the material to be compacted, as well as the establishment of regularities of this interaction [3].

The proposed design of a vibrating plate with variable working bodies is presented in Figure 1, created on the basis of theoretical calculations and design developments, provides the possibility of selecting the optimal type of working surface for each type of material [4]. This allows to achieve increased uniformity and quality of compaction of soils and bulk materials, which significantly expands the functionality of the equipment.

Fig. 1 - Vibrating plate with replaceable working bodies

In order to find the degree of influence of material moisture φ, the time of influence of the vibrating plate t on the material and the frequency of rotation of the vibrating exciter n on the efficiency of the experimental equipment, the functional dependence of the influence of the above parameters on the shrinkage $\varDelta y$ of the investigated compacted surface of the material in the form was determined

$$\varDelta y = f\ (\ t,\ n,\ \varphi\ ). \tag{1}$$

It was customary to use a three-factor experiment of the second order to conduct research experiments. The implementation of this experiment and the processing of the obtained data make it possible to obtain a mathematical model of compaction with a vibrating plate in the form of a regression equation

$$y_i = 25{,}748 + 6{,}3x_1 + 0{,}7x_2 + 1{,}4x_3 - 2{,}799x_1^2 - 0{,}799x_2^2 - 0{,}299x_3^2 + \\ + 0{,}125x_1x_2 + 0{,}625x_1x_3 + 0{,}375x_2x_3 \tag{2}$$

Considering the effect of a smooth surface on the building material: 1 – sand, 2 – soil, 3 – granvids, we get an image of three 3D surfaces that characterize the effect on the shrinkage of the material and are depicted in Figure 2 – 4.
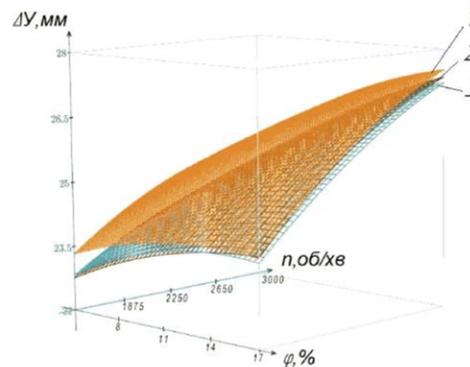

Fig. 2 – Graph of the dependence of shrinkage $\varDelta y$ of the material at a fixed time $t=90$ in the range of rotation frequency $n=1500...3000$ and humidity $\varphi=5...17\%$
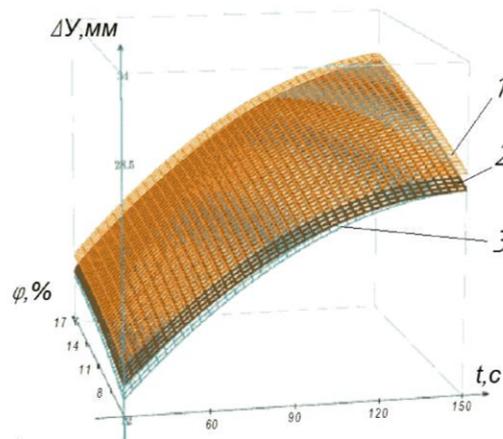

Fig. 3 – Graph of the dependence of material shrinkage $\varDelta y$ at a fixed rotation frequency $n=2250$ in the humidity range $\varphi=5...17\%$ and time $t=30...150\ s$.
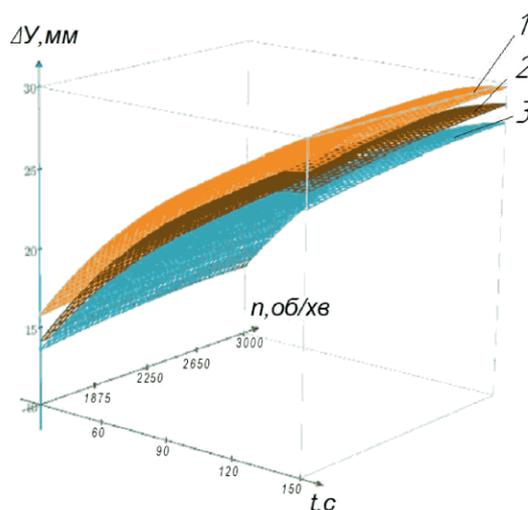
Fig. 4 – Graph of the dependence of material shrinkage *Δy* at fixed humidity *φ=11%* in the range of rotation frequency *n =1500...3000* and time *t=30...150 s*.

Conclusions

The analysis of the obtained graphic dependencies shows that the duration of the compaction process has the greatest influence on the amount of material shrinkage. However, as the compaction time increases, the energy consumption also increases, so this parameter should be maintained within optimal limits. The second most important factor is the moisture content of the material: at its values that are too low, part of the energy is spent not on compaction, but on grinding the particles, which reduces the efficiency of the process. The third factor — debalance rotation frequency — has a smaller effect, but is decisive for the stability of the oscillating mode. The optimal value of this parameter is n ≈ 3000 rpm, which provides a rational ratio between vibration intensity and energy consumption.

References

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