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DISTINCTIVE FEATURES OF VIBRATIONAL COMPACTION OF SUBGRADE SOILS WITH ROLLERS

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Abstract. The article presents the rollers used in subgrade compaction of automobile roads and their main technical, technological descriptions. Also in the working bodies of compaction machines, information is given on the vibroelements and their use, which cause the vibrational process. In particular, the analysis on the importance of vibration compaction in the provision of compaction coefficient is described.
Key words: compaction, subgrade, vibration, soil, roller, strength, vibration elements, frequency, amplitude, compaction coefficient.

Introduction. Compaction is one of the most important processes performed in road construction. This technological process is important in ensuring the strength, stability and load-bearing capacity of the road structure. The methods of processing soil on the roads being built are of different appearance, including digging, pushing, leveling, planning work, compaction. In particular, in road base construction, compaction processes are carried out by soil rollers [1,2,3].

LITERATURE ANALYSIS. Vibrational compaction is a complex process, and in many ways depends on more than 30 factors that belong to the characteristics of the roller working organs and grunt. In particular, in the process of compaction, the dimensions corresponding to the machine and the soil are as follows:

constructive parameters:
- machine and frame dimensions;
- width and diameter of the working body.

technological parameters:
- walking speed;
-number of passes.

dynamic parameters:
- mass distribution,
- linear pressure on drum,
- vibration parameters:
- awakening force;
- amplitude;
- frequency.
- **subgrade soil properties:**
- getting involved;
- internal friction angle;
- deformation module;
- compaction coefficient.

Vibrating rollers are currently produced by the world's leading companies. At the same time, scientific research is being carried out on the research of the processes of interaction between machine working bodies and soils [4,5]. Let's get acquainted with some of their brands. In particular, Bomag, one of the German companies, is one of the modern compaction machines. Although relatively large in size, it has a lot of amenities. The superficiality of the design allows it to be used on small construction sites.

Figure 1. Bomag company rollers.

The Hamm Company also produces about 40 models with a mass of 5 tons to 25 tons. Through Control Panel devices, we can view indicators such as engine performance, fuel quantity, cooling liquid level, hydraulic oil and temperature, oil pressure in the engine, speed of movement, frequency as operational data. The vibration system and the speed of the cathode motion are controlled in an electronic Tableau to match the engine rotation to improve the quality of compaction, with low fuel consumption. A specially designed three-point binder provides course stability and ease of control.

Figure 2. Hamm company rollers.

Currently, **Atlas Copco (Dynapac)** is producing the fifth generation of grunted rollers, which includes around twenty models. In this compaction machine, in contrast to other rollers, special attention is paid to the place of operator work. The cabin is wide inside and the operators workplace is limited. The seat is equipped with armrests and button couplers. The steering column has a monolithic mod of steering and the operator's seat becomes 1800 inside the cabin, which in turn also makes it easier to walk backwards. The compaction meter, which has the active control function of the vibration system, reduces the amplitude when it comes close to the given compaction level, while when full compaction is achieved, it turns off the vibrator and sends a signal to the display.

Figure 3. Dynapac compaction machines.

The rollers produced by the Ammann company consist of seven types of compaction machines, ranging from 5 to 25 tons. Like other machines, the operator in the first place is the convenience of the workplace. There is a wide view of the cabin through the rear window at the expense of the low hood. Such a configuration allows you to apply a structure without a rear bridge. The ASE control and measurement system controls the automatic amplitude and frequency in accordance with the grunt description. By the norm of compaction, the amplitude is reduced and the frequency is increased. Preset working speeds provide an alternative relationship of frequency vibration.

Figure 4. Ammann road rollers.

The largest of the Russian manufacturers, «Raskat» produces six-model soil roller ranging from 11 tons to 21 tons. One thing should be noted separately that these compaction machines are produced using planetary reducers from “Bonfiglioli Bondioli Pavesi”, including an engine by Deutz, a hydraulics system from “Sauer-Danfoss”, imported components supplied by the manufacturers of the world's leading company. Rollers use high-performance cabin and drum amortization. The machine is equipped with a pneumatic tire with a tread, which ensures smoothness.

Figure 5. Raskat aoil rollers.

RESEARCH METHODOLOGY.

All of the compaction machines mentioned above are in dynamic effect, compacting soils and asphalt concrete blends in a vibrational fashion. This in turn will depend on the type, shape and fastening methods of vibroelements installed in the roller drum shaft [6,7]. Also important is the fastening and arrangement of the elements of the shaft. debalance and ossylation, which are located in the compaction shaft. We can see these cases from Figure 6 below..

Circular debalance **Two debalance vibrator with shaft** **Oscillation**

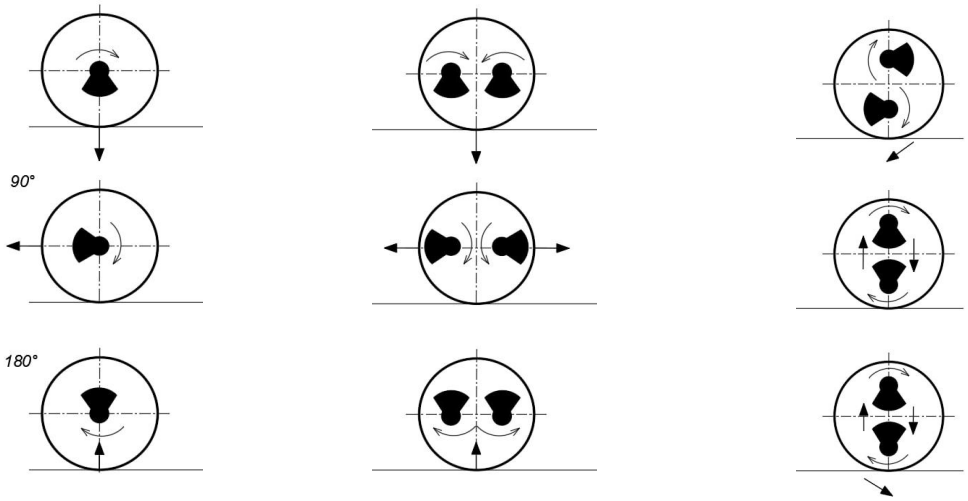

Figure 6. Debalans of vibrational mechanisms layout scheme.

Various schemes of vibrator debalances are shown in Figure 7. The rotation of the debalance causes the generation of rotational force and rotational moment (Figure 6,a). In initial phasing,the force and moment along one line in rotation of two identical debalances around a parallel axis to the opposite side produce a dynamic screw oscillation in syngas and antifase content in the oscillation (Figure 6, s). The direction of the rectilinearly directed arousal force can be generated by a single rotating debalance in the pendulum vibrator banding (Figure 6,b). In this, the evoking force acts along the middle position of the axis of Pendulum symmetry.

The singular debalance produces a circular arousal force (Figure 6, d). A similar force can be generated by two debalances in a syngas rotation in one direction around a parallel axis (Figure 6, e). The sinusoidal oscillating rectilinear directed arousal force can be evoked from rotating two identical debalances in the opposite direction around the common axis (Figure 6,f). The Sinusoidal variable moment is provided by two debalances that rotate antiphasically to one side around parallel axes oriented perpendicular to the plane of the form (Figure 6,j).

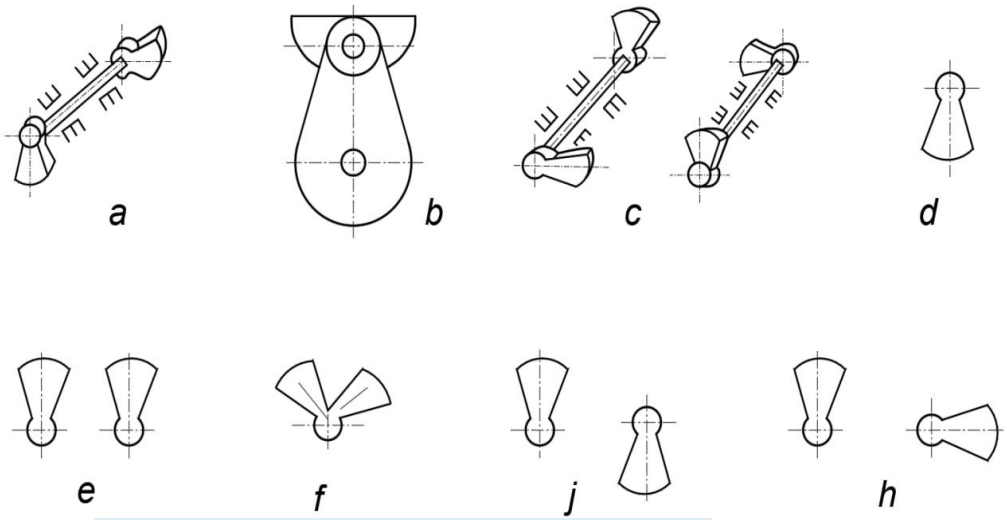

Figure 7. Frequency fluctuations that occur when the oscillation frequency changes.

DISCUSSION AND RESULTS.

It is also necessary to take into account the characteristics of the interacting external environment i.e. grunt when the above-mentioned vibrational cathodes are applied. In particular, the amount of salinity of the soils being used for the road foot is significant in the amount of salt in use. One of the required magnitudes is the degree of wetness of the soil, and it is one of the factors that need to be considered when building a road base. For this reason, the concept of the most favorable humidity is introduced in the compaction of road foot grunts. Another required indicator is the maximum density magnitude. There are also the required compaction coefficient values of the road base layers being built. These magnitude indicators are the parameters corresponding to the soil.

Also important are the vibrational parameters belonging to compacting machines. In particular, there are acceptable values of amplitude and frequency values affected by vibroelments (debalance and oscillation) attached to the valve of the roller working body.

These magnitude indicators are presented in Table 1.

The main factors in compaction

Table 1

O /N	Parameter description	Designation	Size unit	Calculated expressions
1	**Soils property**	Slip resistance	%	$S_{pw} = p \ \ tg\varphi + \ \ _w + C_c$
		Humidity coefficient	%	$S_r = \frac{W}{W_{cheg}}$
		The most comfortable humidity	%	$P_{\max} = f(W_{opt})$
		Soil density	kg/m^3	$\rho = \frac{m_{gr}}{V_{gr}}$
		Compaction coefficient	-	$K = \frac{P_d}{P_{d\max}}$
2	**Vibration parameters**	Awakening force	N	$Q = m \ \ r \ \ \omega^2$
		Frequency of oscillations	hers	$\omega = \frac{\vartheta^2}{0{,}04}$
		Amplitude	mm	$A = \frac{m}{M} \ \ r$
		Centrifugal force	N	$P = e \ \ r \ \ \omega^2$

CONCLUSIONS AND SUGGESTIONS.

From the above points, it can be concluded that the main technical economic effect in compacting road structure soils will depend not only on the structural, technological and dynamic parameters of the machines, including the physical mechanical properties of the soil and to what extent the technological processes are organized. In this regard, it is proposed to include the results obtained on the basis of experiments in regulation documents and regulatory documents in the field.

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