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A New Method Of Soil Compaction By The Method Of Soil Loosening Wave

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ABSTRACT

The pressure is released, the rapidly reduced external load is carried away by the volume of the porous medium, which calls for the expansion of the gas enclosed in the pores, seeking to push apart the solid skeleton. Due to this, additional tensile stress may occur in the soil.

KEYWORDS

Wells, drilling, deformation, critical methods, soil, high-pressure gas.

INTRODUCTION

The method is designed for punching and drilling horizontal and vertical wells in dense soils with optimal humidity. This method is used:

1. When laying water and gas networks of small and large diameter pipes;
2. Under highways, highway streets;
3. During the reconstruction of water and gas networks in the territories of plants, factories and other enterprises;
4. Under railway and other structures.

This method is based on the known properties of compressed gases in which they perform certain mechanical work. The essence of the method is that a high pressure of 3-15 atm. is

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injected into the drilled well. Around a pristine well environment, the gas pressure is balanced by counteracting the pressure in adjacent pores to create a volumetric compression with potential energy accumulation.

As the pressure in the well is maintained, its internal pressure will increase due to the permeability of the soil and after a while reaches the value of the external pressure while the potential energy of the gas located in the pore space significantly exceeds the value of the potential energy of the elastic deformation of the medium called the "Deryagin Effect" [1].

The phenomenon of adsorption changes in the strength of solids reasonably developed by the theory of Rebender [2] is expressed with the entrainment of their deformations and a decrease in the critical yield strength and fracture performance.

The free flow of the ground mass caused by the expansion of the high-pressure gas contained in the powder after crushing is justified by acad. S. A. Khristanovich [3] the flow of a ground mass consisting of small solid particles under the influence of the expansion of a high-pressure gas contained in the initial state into the powder of the ground mass is considered. As shown by the study at a small and even quite significant porosity can not even approximate to assume the expansion of the gas.

RELATED WORK

The method and results of determining the deformation characteristics of samples at their gas saturation are given in [2,5,7,8] under strong even conditions, the saturation gas can be dangerous at lower external loads, lower stress state. If you suddenly create a compression surface and the adjacent zone there is an unbalanced force of the compressed gas in the direction of compression. The magnitude of this force will be the greater the higher the pressure gradient, the area to which it is applied. In this case, around the well there is a redistribution of the stress state of the soil mass and there is a destruction of the natural structure and mixing of the soil with a change in porosity.

Such a phenomenon occurring in the soil was first investigated by N. M. Gersevanov, L. E. Polshinim, V. G. Bulychev, V. A. Florin [3,4,5,6]. investigating the nature of samples taken from a great depth for the purpose of developing engineering measures for caisson work, they found that the decrease in pressure on the surface of the soil leads to its expansion. They found that even small fluctuations in atmospheric pressure also cause soil deformation. The processes occurring with the I at the same time in the soil have also been studied and mainly the study of changes in the volume of the soil due to trapped air. This study formed the basis of the theory of vapor and gas formation, to explain the phenomena of soil swelling under compressions of natural load. Rapid changes in pressure on the surface of clay soils have a significant impact on their stress-strain state, which is confirmed by many multiple examples.

Confirmation of their research G. M. Lyakhov and G. I. Pokrovsky [7,8] found that the value of the realized soil energy is determined not only by the physical and mechanical properties of its skeleton and the value of the initial state due to the presence of fluids in the powder.

When the pressure is released, the rapidly reduced external load is carried away by the volume of the porous medium, which calls for the expansion of the gas enclosed in the pores, seeking to push apart the solid skeleton. Due to this, additional tensile stress may occur in the soil.

As a result of strains of tension and compression under the action of normal and tangential stresses, the force of adhesion between the rock-forming links in the zone adjacent to the counter of the massif is sharply reduced. The nature and speed of the destruction of the soil structure in the conditions of unloading depends on the speed of its exit from the conditions of external compression. It is obvious that beyond which point in time in the weakened cross-section the cohesion rupture forces will prove to be equal in magnitude to the pressure and volume of gas applied in the array.

The rate of decompression of the gas-saturated medium can increase if the value of stresses is realized in strains, stresses, continuously decreases, in the ideal case of 10-30 times the value with respect to the initial level. This is because the force of the gas is produced the pressure on the area to which it is attached, not loaded environment is limited to the area middleware section since.

L. I. Sedov, G. M. Lyakhov investigating [9,10,11] it is established that at fast unloading of soil the rarefaction wave arising in elastically compressed gas at the moment of their fast unloading can arise is considered as a plane wave [12,13].

The wave of destruction should be distinguished from the seismic wave. A seismic wave propagates in the ground from any source of damping at a speed close to the speed of sound in a homogeneous medium. The state of the soil does not change, since the particles of the medium only oscillate near the equilibrium position.

MAIN PART

When a flat wave propagates in a homogeneous medium in a well with compressed air injection, a flat one-dimensional motion of all its particles lying in any density perpendicular to the direction of motion takes place. The particles of the medium under these conditions have the same mixing, velocity, acceleration and stress.

The state of the medium realized in these cases is due to stretching under conditions of impossibility of current expansion and is a uniaxial deformation state [15,16,17]. Deformation coincide in the direction of the motion of the medium, which is opposite to the direction of propagation of the vacuum wave. The deformation corresponds to a direction perpendicular to the direction of motion equal to zero ($\varepsilon 1 = \varepsilon 2 = 0$), the difference from zero is only the deformation si coinciding in the direction of motion with the motion of the medium.

When the pressure gradually increases in the soil, elastic compression occurs due to deformation of solid particles at their contact points.

The generalized Hooke law defines the relationship between the principal stress and the principal strain as:

$$\varepsilon_1 = \frac{1}{E}\left[\sigma_1 - \vartheta\left(\varepsilon_2+\varepsilon_3\right)\right]$$
$$\varepsilon_2 = \frac{1}{E}\left[\sigma_1 - \vartheta\left(\varepsilon_2+\varepsilon_3\right)\right] \quad (1)$$
$$\varepsilon_3 = \frac{1}{E}\left[\sigma_1 - \vartheta\left(\varepsilon_2+\varepsilon_3\right)\right]$$

Where do we find

$$\sigma_2 = \sigma_3 = \frac{\vartheta}{1-\vartheta}\sigma_1 \quad (2)$$

$$\varepsilon_1 = \frac{(1+\vartheta)(1-2\vartheta)}{E(1-\vartheta)}\sigma_1 \quad (3)$$

Where σ_1 are the stresses acting in the direction of motion of the medium.

$\sigma_2; \sigma_3$ -tangential voltages

ϑ -Poisson's ratio

E -elastic modulus

When describing dynamic processes, the dynamic Poisson's ratio "Elastic modulus" is used [1,6,3].

$$\vartheta = \frac{0.5-R^2}{1-R^2} \quad (4)$$

$$R = \frac{C_s}{C_p} \quad (5)$$

Where are the velocities, respectively, of the transverse and longitudinal waves in the medium$C_s C_p$

$$E_q = \frac{\gamma}{q} C_P^S \frac{\left(1-\vartheta_q\right)\left(1-2\vartheta_q\right)}{\left(1-\vartheta_q\right)} \quad (6)$$

γ volumetric weight q acceleration gravity

Denote $\frac{\gamma}{q} C_P^S = \text{E0}$ (7)

Substituting dynamic parameters into formula (3), we obtain

$$\varepsilon_1 = \frac{\sigma_1}{E_0} \tag{8}$$

Denoted $\frac{\gamma_q}{1-\gamma_q} = K_1$ (8)'

For a uniaxial deformed state of the medium, we obtain the relationship between stress and strain in the form:

$$\sigma_1 = E_0 \varepsilon_1 \tag{9}$$

$$\sigma_2 = K_T \delta_1 \tag{10}$$

Taking into account the mechanical action of the gas on the stress state of the medium, it was proved [18] that the actual stresses tested by the skeleton of the medium in the intact massif can be less by the value of the gas pressure or remain unchanged depending on the strength of the properties of the rock-forming grains and the relative contact area between them.

In soils, the skeleton of which consists of cemented quartz grains with a strength limit of 15x103 kgs / cm^2

External compressive forces are transmitted through their contact surfaces.

Under these conditions, the actual stresses tested by the skeleton of the environment is determined by the expression

$$\sigma_\varphi = \sigma - \left[1 - \delta\left(1 - m\right)\right] P \tag{11}$$

Where is the stress in the array without taking into account the mechanical action of compressed gas, kgf / cm^2 σ

m unit fraction porosity

R gas pressure from.

σ the ratio of the contact area to the total surface of the rock-forming grains.

Thus, the gas in the pores of the intact massif has complex physicochemical and mechanical effects on changing the properties and state of the medium, can be calculated by the formula

$$\sigma_1 = \frac{\gamma C_1 U}{q} \tag{12}$$

Where *U* is the mass velocity of mixing of a particle of the medium.

Minimum voltages behind the front of the discharge wave

$$\sigma_{min} = \frac{\gamma C_p U_r}{q} \tag{13}$$

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Energy expenditures in overcoming the adhesion forces between the structural elements of the volume of the medium V-can be calculated by the formula [9,10]. Or given the formula

$$E_{cy} = \frac{1}{2}\sigma_{min} V \varepsilon \tag{14}$$

Or taking into account the formula (8^1)

$$E_{cy} = \frac{\sigma_{min}^2}{2E_0} \tag{15}$$

The reserves of the total energy of the discharge wave in the volume of the medium (*V*) are expressed

$$E_n = E_{nom} + E_{KHT} = \frac{\sigma_1 V}{2E_0} + \frac{\frac{\gamma}{q} VU^2}{2} \tag{16}$$

where E_{nom} is the potential energy of elastic deformation of the medium.

E_{KHT}- kinetic energy of particles moving behind the wave front.

Substituting into formulas (15) and (16) the value E0, σ_1, σ_{min} respectively from the formula

$$E_{cy} = \frac{\gamma u_2^2}{2E_0} \tag{17}$$

$$E_n = \left(\frac{\gamma u^2}{2q} + \frac{\gamma u^2}{2q}\right) \tag{18}$$

Calculation of energy consumption for longitudinal adhesion forces between the structural elements.

To determine the porosity of the rock mass taking into account the stress-strain state, we represent the specific gravity of the loaded medium by the expression.

$$\gamma_i = \frac{p}{V_i} \tag{19}$$

where *P* is the weight of a rock volume unit.

V_i- the value of a unit volume of rock under load in turn.

$$V_i = V - AV_i \tag{20}$$

$$\Delta V_i = V\theta \tag{21}$$

$$\theta = \varepsilon_x + \varepsilon_y + \varepsilon_z; \text{–or} - \theta = \varepsilon_ч + \varepsilon_y + \varepsilon_z \tag{22}$$

where ΔV_i the incremented volume when it is loaded

V - unloaded sample volume

θ - dilatation is the relative change in volume,

ε - relative deformation.

Then

$$V_i = V(1-\theta) \tag{23}$$

Substituting the value into formula (19), we obtain V_i

$$\gamma_i = \frac{\gamma}{1-\theta} \tag{24}$$

Taking into account (24) the pore volume, we can express the dependence

$$V_{nop} = \left[1 - \frac{\gamma_i}{\gamma_i(1-\theta)}\right]100\% \tag{25}$$

The stress state of the rocks around the excavation according to the work (21) consists of the components of the main stresses $\sigma_x, \sigma_y, \tau_{xy}$ due to the stress state of the plane without additional stress components $\sigma_{x2}, \sigma_{y2}, \tau_{xy2}$ by the presence of holes.

We will consider these problems for an elastic isotropic non-ripple rock mass around the well.

Such an assumption is entirely valid, since the value of the porosity of rocks determined here is considered in relation to the conditions for carrying out a soil massif. [20]

According to work [20] displacement caused by the main stresses will be equal

$$U_1 = -\frac{\gamma Hr}{4C}\left[(1-2\gamma)(1+\lambda)-(1-\lambda)cos2\varphi\right] \tag{26}$$

$$V_1 = -\frac{\gamma Hr}{4C}(1-\lambda)sin2\varphi \tag{27}$$

Displacement from additional stresses

$$U_2=-\frac{\gamma Hr}{4C}(1+\lambda)\frac{R}{2}-\left[4(1-\lambda)\frac{R}{2}-\frac{R^3}{2^3}\right](1-\lambda)cos2\varphi \quad (28)$$

$$V_2=-\frac{\gamma Hr}{4C}\left[2(1-2\vartheta)\frac{R}{2}+\frac{R^3}{2^3}\right](1-\lambda)sin2\varphi \quad (29)$$

where H is the well depth

R- well radius

C, γ - elastic constants of the soil mass

φ, r - coordinates of an array point in polar coordinate system

Determine the total displacement

$$U=U_1+U_2=\frac{\gamma H}{4C}\left[(1-\lambda)\left[r(1-2\vartheta)+\frac{R^2}{Sr}-(1-\lambda)cos2\varphi\left[1-4(1-\vartheta)\frac{R^2}{2}-\frac{R^4}{2^3}\right]\right]\right] \quad (30)$$

$$V=V_1+V_2=-\frac{\gamma H}{4C}\left[r+r(1-2\vartheta)\frac{R^2}{r}-\frac{R^4}{r^3}\right](1-\lambda)sin2\varphi \quad (31)$$

This expression allows you to determine the magnitude of the corresponding deformations.

$$\varepsilon_s=\frac{\partial U}{rS};\varepsilon_\varphi=\frac{\partial U}{\partial\varphi}+\frac{U}{r} \quad (32)$$

Substituting the value of (32) $\varepsilon_s, \varepsilon_\varphi$ and $\varepsilon_z = 0$ formula (25) determine the value of the porosity at the point of the array with coordinates φ, s.

The performed numerical calculations based on the dependences carried out show the difference in the porosity of the intact soil mass from the unloading of the samples reaches 20-40%

For carrying out the values obtained analytically, a method was developed and a stand was created under certain laboratory conditions.

Determination of the radius of change in the unloaded action of wells is growing from its wall to the point where the voltage component γh is determined by V. Khodot [21] on the basis of analytical and laboratory research according to the formula

$$R_m=r+\frac{d}{2\sqrt{rf\lambda}}ln\frac{\gamma h}{k_y} \quad (33)$$

r - the radius of the bore

d – bore diameter

γ - volumetric weight of the rock

f - soil friction coefficient

k - resistance to soil shear

$$\lambda = \frac{1+sin\rho}{1-sin\rho}\gamma = \frac{2xcos\rho}{1-sin\rho}$$

Constants depend on coal internal friction

ρ - angle of internal friction

However, for the above-mentioned intensification of the drilling process of solid soils, the author has developed an installation that consists of a drilled well, a load system, a control system and measuring equipment.

It implements images of the author of the proposed solution. (Author's certificate No. 761540 No. 863760).

EXPERIMENTAL RESULTS

The working body of the baking plant consists of a hollow cylinder and a baking body. The auxiliary part consists of: two working chambers with valve mechanism and control system.

The working body is controlled over the top of the well, the disintegrating body, the loading system is lowered into the well, seals the exhaust of compressed air from the holes of the working chamber, the soil is destroyed, by alternating in it the excess compressed pressure with atmospheric pressure.

The borehole system includes a DC-9M or KVDG-60 compressor, receiver, borehole drilled and solenoid valves for the supply and discharge of compressed air. The compressed air is produced by the compressor, cleaned in the cleaning system and fed into a receiver consisting of three connecting cylinders connected in series. A constant level on the receiver is maintained with the help of an electro contact pressure gauge EKM-25U, which provides automatic switching on at the right time.

From the receiver, the compressed air through the exhaust solenoid valves, which provide an adjustable system pneumatically actuating mechanism, enters the well.

Electro-contact pressure gauges EKM-25U are installed at the installation, which ensure the constancy of the set pressure in the well.

When reducing the pressure in the well, the pressure gauge drops signals to the pneumatic distributor Ferpi-80, acting with the help of an automatic air supply system of 0.15 MPa, on the actuators of the inlet valve in the well.

CONCLUSION

The command electro-pneumatic device KEP-12U according to the specified cycle program, carries out the control system of the installation automatically. This device consists of an electric motor, a camshaft, a constant-ratio gearbox and a four-section gearbox.

Cams located on the camshaft reset and cocked latches high-speed switches. The consequences act on the pistons of pneumatic spool, and those in turn on the actuators of the solenoid valve, opening or closing them.

The number of completed cycles loaded with reset is recorded by counters BE-R-b TSAT-2M.

The measurement system is based on strain and ultrasonic and pulse methods. As the measuring equipment the digital piezometric bridge CTM-5 is used, allowing to register changes of relative deformations of soil by means of the tensometer tensor of resistors with the subsequent registration of their digital printing device SD-107D; the 16-channel light-beam oscilloscope N-041-Uch2 and the 8-channel tensometric amplifier ANE-7M on a photo paper of change of relative deformations in the process of loading. Ultrasonic concrete is used by UKB-1M to record the propagation time of the ultrasonic pulse, the attenuation time and the shape of the envelope change, which allows obtaining more complete information about the structural violations of loosening fractures in the soil mass.

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