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ANALYSIS OF SHEAR RESISTANCE OF THE EARTH, TAKING INTO ACCOUNT THE CHANGE OF THE TEMPERATURE MODE OF WORK OF THE CONSTRUCTION OF ROAD CLOTHING

The design of pavement largely depends on the climatic conditions, which must be taken into account both in the design process and at the stage of calculating the pavement and the working layer of the ground. Climatic conditions significantly affect the operating conditions of the road structure.

At present, when designing non-rigid pavements in Ukraine and Morocco, zoning of the territory is used, according to natural and climatic factors. Insufficient consideration of natural and climatic factors in the design of non-rigid pavements will lead to inconsistency of design values of deformable and strength characteristics of materials of coating layers and the base to the actual operating conditions of the structure, and as a consequence to premature destruction and additional repair costs. Therefore, it is advisable to analyze the impact of changes in temperature of the pavement structure on the shear resistance of the ground.

According to the current order of calculation in Ukraine under the condition of shear stability of the subsoil [1, 2], the calculated parameters of materials (values of modulus of elasticity of materials) are determined depending on the temperature only for materials containing organic binder. The calculated temperature varies from 20 ºС for the conditions of the road-climatic region У-I to 35 ºС for the conditions of the southern part of the road-climatic region У-IV [1, 2]. Therefore, when modeling the stress-strain state in order to analyze the effect of temperature changes on the stress-strain state and shear resistance of the ground changes the design temperature and, accordingly, the modulus of elasticity and Poisson's ratio of only asphalt concrete layers.

Based on modern ideas about the influence of structure and texture on the stress-strain state of a solid body, in the study of asphalt concrete layers, the material is accepted as a quasi-homogeneous, quasi-isotropic body [3, 4]. In this case, the idealization of the real environment with respect to its homogeneity, the continuity of isotropy does not lead to fundamental errors in the calculations of the general solutions of the theory of elasticity [3-5].

The finite element method was chosen as a mathematical apparatus for modeling the stress-strain state of the ground. The calculation model is four-layer, consisting of three layers of pavement and one layer - the base (simulating the soil of the ground).

The parameters of the calculation model are selected as follows – each layer is characterized by thickness, modulus of elasticity and Poisson's ratio. The basis is characterized by the general (equivalent) modulus of elasticity and Poisson's ratio.

Simulations were performed for the improved lightweight type of road clothing (standard static load on the 100 kN axis, standard static load on the surface of the coating from the wheel of the design car 50 kN, tire pressure 0.6 MPa, wheel imprint diameter 0.371 m) according to [6] and the conditions of the North-Eastern region according to [7].

The modulus of elasticity of asphalt concrete layers varies depending on the temperature in the range from 25 ºC to 30 ºC, and is determined according to [7]. As a result of modeling the stress-strain state of the soil, the main stresses and stresses according to Mises were determined: σ_1, σ_2, σ_3, σ_m, the values of which are summarized in Table 1.

Table 1 – The values of the main stresses in the soil of the subsoil, determined as a result of modeling

The value of the main stresses, MPa	Model name					
	M1	M2	M3	M4	M5	M6
	estimated temperature of asphalt concrete layers, ºC					
	25 ºC	26 ºC	27 ºC	28 ºC	29 ºC	30 ºC
σ_1	0.169	0.171	0.172	0.174	0.176	0.178
σ_2	0.169	0.171	0.172	0.174	0.176	0.178
σ_3	-0.051	-0.052	-0.052	-0.053	-0.053	-0.054
$\sigma_М$	0.220	0.222	0.224	0.227	0.229	0.232

From the analysis of simulation results it is established that the change of the calculated temperature for each 1 ºC leads to a change of stresses in the soil of the subsoil by about 1 %. The same dependence is valid for loads of 115 kN and 75 kN.

Based on the simulation results, the active shear stresses in the ground soil from the temporary load were determined by the formula [2]:

$$\tau = \left[(\sigma_1 - \sigma_3) - (\sigma_1 + \sigma_3)\sin\varphi\right] / 2\cos\varphi, \qquad (1)$$

σ_1 – maximum main voltage, MPa;

σ_3 – minimum main voltage, MPa;

φ – angle of internal friction, deg.

The results of the calculation of the active shear stresses in the soil of the subsoil from the temporary load and the shear strength factor in the soil of the subsoil at different temperatures are shown in table 2.

A change in the design temperature for every 1 ºC leads to a change in the active shear stresses in the soil and a change in the shear strength factor of the subsoil by a shear of 1%. The simulation results show that it is necessary to determine the design temperature very accurately, especially with a minimum shear strength of the subsoil. In such conditions, the zoning of the territory of the country, which determines the estimated temperature, should be developed according to long-term observations and updated to take into account climate change.

Table 2 – The value of shear stresses in the soil and the coefficient of strength

Parameter	Model name					
	M1	M2	M3	M4	M5	M6
	estimated temperature of asphalt concrete layers, ºC					
	25 ºC	26 ºC	27 ºC	28 ºC	29 ºC	30 ºC
The value of shear stresses in the soil of the subsoil	0.0176	0.0179	0.0179	0.0182	0.0182	0.0186
The value of the coefficient of strength	1.08	1.06	1.06	1.05	1.05	1.02

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REDUCTION OF ROADSIDE AREA POLLUTION DUE TO CONTROL OF EQUALITY AND STRENGTH OF THIN ASPHALT CONCRETE LAYERS ON A HARD BASIS

Recently, the construction of thin-layer asphalt concrete coatings on a cement-concrete basis began to be used frequently both in the reconstruction of roads and in new construction. The asphalt concrete layer should provide the possibility of comfortable and safe movement of vehicles on the road, improved smoothness and traction. Ensured high levelness and strength of the asphalt pavement will allow drivers to maintain a constant high speed of vehicles and reduce