Zemědělství

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INVESTIGATION OF WATER AND HEAT MODE A SUBGRADE HIGHWAY IN THE CONDITIONS OF ORASHAEM DISTRICT IRRIGATED AREAS

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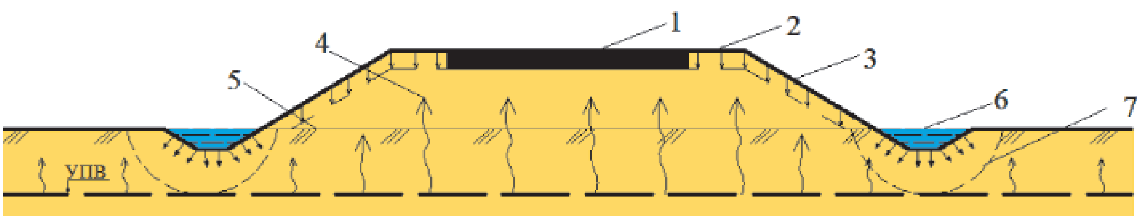
Summary. In this work water-heat regime of the earth roadbed of automobile roads in Uzbekistan's condition has been considered in the article. Differential equations of definition of the water-heat regime of the earth roadbed with creep and close position of the ground water level, as well as side position, have been suggested.

Keywords: Roadbed; humidification; thermo diffusion moisture; road surface; hydraulic conductivity; ground water level; pavement; shoulder; capillary water; situ soil; collector; percolating water.

For the design of the roadbed in irrigated areas with specified strength properties must forecasting of quantitative indicators of water and thermal regime. Literary analysis of the results of the water regime subgrade leads to the conclusion that, in the arid zone, especially in irrigated areas, the main sources of moisture are working layer groundwater regime that is closely related to watering. The mechanism of hydration is associated primarily with lateral capillary rise and moisture. Above let us imagine a scheme (see picture), which could be used to describe the subgrade in the dry climate.

Analysis sections of road on moisture conditions in accordance with the present scheme allows to prove humidity effects on road construction in artificially irrigated areas. An analysis of the oversight of the scheme grounded theoretical methods for calculating water and thermal regime of the three types and the following differential equations.



Scheme humidification of the working layer of subgrade:
1 – pavement; 2 – shoulder; 3 – atmospheric water; 4 – capillary water; 5 – situ soil; 6 – collector; 7 – percolating water from reservoir.

Differential equations of water and thermal regime of the floor of the road at a spot deep hydration. For road, sections with deep occurrence of groundwater levels can be applied the general theory of heat and mass of developed by A. V. Likov [1] for capillary porous bodies and developed by V. M. Sidenko for road construction [2]. The migration of moisture and heat (heat exchange) in the fabric provided the soil uniformity could be represented as follows:

$$\frac{\partial t}{\partial T}=\alpha\frac{\partial^2 t}{\partial z^2}+b\frac{\partial W}{\partial T}; \qquad (1)$$

$$\frac{\partial W}{\partial T}=\alpha_1\frac{\partial^2 W}{\partial z^2}+\alpha_1 b_1\frac{\partial^2 t}{\partial z^2}. \qquad (2)$$

where α – coefficient of thermal conductivity of soil; m²/h; b – coefficient characterizing the generation or absorption of heat soil moisture due to phase transformations, hail; α_1 – coefficient of hydraulic conductivity of soil moisture biphasic, m²/h; b_1 – thermo migration coefficient (thermo diffusion moisture), 1/h; z – is the depth (variable coordinate) m; t – time, hour.

For our case, we have the boundary and initial conditions:

For humidity:

$$W(Z;0)=W_H;$$
$$W(0,t)=W_H+m_1 t; \qquad (3)$$
$$\left.\frac{\partial W}{\partial Z}\right|=0.$$

For temperature:

$$T(Z;0)=T_H;$$
$$T(0,t)=T_H-m_2 t; \qquad (4)$$
$$\left.\frac{\partial T}{\partial Z}\right|=0,$$

where W_H, T_H – initial distribution of humidity and temperature with depth; m_1, m_2 – to coefficient of characterizing the intensity changes in humidity and temperature during the cold period. Here is $m_1 = 1/h$ and $m_2 = \mathrm{deg}/h$.

An analysis of some mathematical transformations and the final expressions for determination of moisture canvases have the form:

$$W(Z,t)=W_H+m_1 t+\frac{\sqrt{\pi}}{2}\sqrt{\frac{\alpha}{\alpha_1}}\left(1+\frac{2b_1\alpha_1 m_2 t}{\sqrt{\pi(\alpha-\alpha_1)}}\right)erf\left(\sqrt{\frac{\alpha}{\alpha_1}}\frac{Z}{2\sqrt{\alpha t}}\right)-\frac{\sqrt{\pi b_1}\alpha_1 m_2 t}{2(\alpha-\alpha_1)}erf\left(\frac{Z}{2\sqrt{\alpha t}}\right); \qquad (5)$$

$$T(Z,t)=T_H-m_2 t\left[1-erf(\eta)\right],$$

where $\eta=\dfrac{Z}{2\sqrt{\alpha t}}$.

Observations have shown that t ranges from 1 to 4 months. Therefore, the m_1 values range from $1\cdot10^{-5}$ prior $5\cdot10^{-5}$ 1/h. Thermal diffusivity of α, α_1 and hydraulic conductivity of heat and moisture b_1 were taken from laboratory examination [2].

In this case, the values of these coefficients adopted:

$$\alpha = 0{,}001\ \mathrm{deg/h},\quad \alpha_1 = 7\cdot10^{-5}\ \mathrm{m^2/h},$$

$$m_1 = 2{,}5\cdot10^{-3}\ \mathrm{m^2/h},\quad b_1 = 0{,}002\ \mathrm{1/deg},$$

$$W_H = 0{,}16,\quad Z = 0{,}2,\quad t = 700\ \mathrm{h}.$$

The distance from the bottom of the pavement to RGUV in the study area taken equal to 3 m. Then the values of $W(Z, t)$ according to formula (5) equals to 0,17.

Differential equations of water and thermal regime of the road surface in a side humidification. Consider the problem of moisture exchange in the soil canvas without heat and moisture in the presence of lateral sewers that affect the change of moisture in the web. Equation moisture distribution will be:

$$\frac{\partial W}{\partial t}=\alpha_1\frac{\partial^2 W}{\partial z^2}. \qquad (6)$$

The initial condition is $W(Z, 0) = W_H$, the boundary conditions will be:

$$W(z, 0) = W_H;$$
$$W(0, t) = W_1; \qquad (7)$$
$$W(l, t) = W_H + mt,$$

where l – the distance from the bottom of the pavement to the groundwater level in the period of its maximum distance, m.

We introduce a similar variable and after some mathematical transformations final expression for determining the temperature and humidity paintings are of the form:

$$W(Z,t) = \left(W_H - W_1 + m_1 t\right) \frac{erf\left(\frac{Z}{2\sqrt{\alpha_1 t}}\right)}{erf\left(\frac{l}{2\sqrt{\alpha_1 t}}\right)} + W_1. \qquad (8)$$

Equation (8) shows that the humidity near the source side will rise humidification and achieves a maximum value equal to $W_H + mt$.

The values of the coefficient m were analyzed previously for a period of stagnation of water in the ditches. m values were calculated using the formula:

$$m = \frac{W_K - W_H}{t}, \qquad (9)$$

where W_K, W_H – the final and initial soil moisture under the edge of the carriageway for the period t ranges from 1 to 6 months. However, the period of standing MGPV from 1 week to 1 month. At the appropriate table with this value of m_1 varies from $1\cdot10^{-5}$ 1/h. Thermal diffusivity α, and α_1 hydraulic conductivity of heat and moisture b_1 were taken from laboratory studies [2]. The width of the roadside for the study area is 2–2,5 m.

In this case, the values of these coefficients taken $\alpha_1 = 2\cdot10^{-5}$ m²/h, $m_1 = 2\cdot10^{-5}$, $b_1 = 0{,}002$ 1/deg, $W_H = 0{,}24$, $W_1 = 0{,}32$, $Z = 0{,}2$, $t = 3$ m. Then, the value $W(Z, t)$ according to formula (8) is equal to 0,25.

To provide the desired strength of the roadway portions with long stagnant wastewater must be removed clothes edge by a certain distance l from the collector side. To determine the minimum lateral removal collectors distance l from an edge of the carriageway must produce corresponding transform (8). At $t = t_p$, $W(Z, t) = W_P$ find l:

$$l = 0{,}8z\left(W_H - W_1 + mt_p\right) + 2\pi\sqrt{\alpha_1 t_p}. \qquad (10)$$

Analysis (10) enabled to determine the minimum distance between the edge of the roadway and side of the collector.

If we take $Z = 1{,}0$ m, $W_H = 0{,}16$, $W_1 = 0{,}21$, $m = 5\cdot10^{-5}$ 1/h, $t_p = 2010$ h, $\alpha_1 = 8\cdot10^{-5}$ h²/h, l is obtained:

$$l = 0{,}8\cdot1{,}0\cdot(0{,}16 - 0{,}21 + 0{,}00005\cdot2010) + 2\cdot3{,}14\sqrt{0{,}00008\cdot2010} = 2{,}56 \text{ м}.$$

Analytical solution of water exchange in the web with shallow ground water. As a result of intensive washing fields and hindered drainage, a sharp elevation of the water table (GGV) and a long period of standing. During this period created a substantial risk of a gradual increase of waterlogged soil fabric.

Because soil moisture in the considered area is relatively high, the main form of migration is the liquid phase. In this regard, thermal diffusion of water vapor can be neglected and the equation takes the form of moisture exchange (6).

Analysis of subgrade work in the area of research allows us to take the following boundary conditions:

$$W(z, 0) = W_1;$$
$$W(0, t) = W_1 + mt; \qquad (11)$$
$$W(h, t) = W_0,$$

were W_0 – is the total water capacity; W_1 – is the initial moisture content; m – coefficient characterizing the intensity of the growth of soil moisture fabric under the roadway; h – the distance from the bottom of the pavement to the groundwater level in the period of its maximum state.

To solve (6) with (11) we can write the following equation for the leaf moisture exchange with shallow ground water:

$$W(Z,t) = W_1 + mt\left[1 - \frac{erf\left(\frac{Z}{2\sqrt{\alpha_1 t}}\right)}{erf\left(\frac{h}{2\sqrt{\alpha_1 t}}\right)}\right]. \quad (12)$$

To determine the moisture content of soil under pavement with a close state (1–1,5 m) groundwater levels were calculated $W(Z, t)$ according to equation (12).

Observations have shown that t ranges from 1 to 3 months. However RUGV standing period is from 1 to 2 months. Therefore, the value of m_1 ranges from $2{\cdot}10^{-5}$ to $7{\cdot}10^{-5}$ 1/h. In this case, the values of these coefficients is adopted:

$$\alpha_1 = 2{\cdot}10^{-5}\ \text{m}^2/\text{h}, \quad m = 2{\cdot}10^{-5}\ \text{m}^2/\text{h},$$

$$W_1 = 0{,}16, \quad Z = 0{,}2,$$

$$t = 700\ \text{hour}, \quad h = 1{,}2\ \text{m}.$$

Then, the value $W(Z, t)$ according to formula (12) is equal to 0,22.

To improve water and thermal regime in the core web and increase strength is important elevation of the bottom of the pavement over the calculated groundwater levels. To solve the problem we use the equation (12). After simplification, we obtain the following formula:

$$W(Z,t)\big|_{t\to\infty} = W_1 - m\sqrt{t}\,\frac{h-Z}{2\sqrt{\alpha_1}} - \frac{Zh}{4\alpha_1}. \quad (13)$$

From formula (13) the approximate method can determine h. Depending m, t, α, W_p, W_1 the value h ranges from 0,6 to 1,2 m.

Thus, the analytical solution for the water exchange is defined $W(Z, t)$ in a cloth with a deep and shallow ground water. Also, an analytical solution for the water exchange in a cloth moistened with water from the reservoir side. In a specific example, the values of $W(Z, t)$.

Bibliography

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