Calculation of the Resistance of Soils of the Base

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ABSTRACT

This article describes the physical and mechanical properties of soils, deformation of buildings and structures erected on saline and subsidence soils.
This article describes the defomation of buildings and structures as a result of brittle and deformed soil and changes in the physical mechanical properties of the around.

Keywords: Soil Layer Thickness, Design Pressure, Water Saturation, Saline Soils, Leached Soil.

When calculating bases by deformation, according to SNiP 2.02.01-83, it is necessary to comply with the conditions under which the average pressure P on the base does not exceed the design resistance R.

The design pressure is determined on the basis of solving the problems of the stress state of the foundation with the limitation of the depth of development of plastic zones under the edges of the rigid foundation to 0.25 of the width of the foundation.

The thickness of the soil layer, in which the ultimate strength stresses are allowed, is limited to a certain depth, and when determining the design resistance, the strength characteristics of the soil layer lying directly under the base of the foundation are used.

When soaking a base composed of saline soils, the design resistance must be determined using the strength parameters of the soil in the state of full water saturation, which lies directly under the base of the foundation. In the event of possible flooding of the base and prolonged water filtration, it is necessary to use the strength parameters of the base soils in a state of complete leaching when determining the design resistance.

The design soil resistance of the base is determined by the formula:

$$R = \frac{\gamma_{c1} \cdot \gamma_{c2}}{k}[M_\gamma k_z b \gamma_{II} + M_q(d_1 + d_b)\gamma_{11}^1 - d_b \gamma_{11}^1 + M_c C_{II}] \quad (1)$$

Где γ_{c1} и γ_{c2}- coefficients of working conditions taking into account the peculiarities of the work of different soils at the base of the foundations;

k - coefficient accepted: $k = I$ - if the strength characteristics of the soil (γ and C) are determined by direct tests and k \u003d I, I - if they are taken according to the SNiP table;

k_z- coefficient accepted $k_z = I$ 1 при $b <$ 10 м;

b- footing width, m ;

γ_{II} и γ_{II}^1 average calculated values of the specific gravity of soils lying respectively below the base of the foundation (in the presence of groundwater, it is determined taking into account the weighing effect of water) and above the base, kN/m3;

C_{II}- the calculated value of the specific adhesion of the soil lying directly under the base of the foundation, kPa;

d_b- basement depth - the distance from the planning level to the basement floor, m (for structures with a basement with a width of B ≤ 20 m and a depth of more than 2 m, d_b = 2 m is taken, with a basement width of B> 20 m, d_b = 0 is taken);

M_γ, M_q, M_c– dimensionless coefficients accepted according to SNiP;

d_1- the depth of laying foundations for non-basement structures or the reduced depth of laying external and internal foundations from the basement floor.

When water is filtered through the foundations of structures composed of saline soils, the dissolution and removal of salts occurs with the formation of three zones in the direction of the filtration flow:

1 zone - complete desalinization, where salts are practically absent;

2 zone - partial desalinization where there is complete saturation with water and partial dissolution and removal of easily soluble salts;

3 zone - non-saline soil, where the dissolution of salts does not occur due to filtration through this zone of a saturated solution.

Under conditions of prolonged flooding or prolonged water filtration through the base, the calculated values of the specific gravity of the soil lying above (γ_II^1) and below (γ_II) the base of the foundation should be determined according to the indication of SNiP 2.02.01-83. The coefficient of the working conditions of the foundation soils γ_c1 is recommended to be taken equal to 1.1, and the coefficient of operation of the building and structure in interaction with the base γ_c1 is taken equal to 1.

The reliability factor k is taken equal to 1.

To assess the reduction in the design resistance of the base as a result of soaking and prolonged water filtration, consider a calculation example:

1. A foundation is given with a size l = b = 1.5 m and a depth of laying d_1 = 1.6 m. The base is composed of saline loams. The specific gravity of soils under the base of the foundation and above the base of the foundations in a state of natural density - humidity is 15.6, and in a water-saturated one they are γ_II=γ_II^1=17.4 kN\m3 and d_b=2 m does not change during leaching

It was previously determined that $\gamma_{c1} = 1{,}1;\ \gamma_{c2} = 1;\ k = 1;\ k_z = 1;$

1. We determine the calculated resistance of the soil in a state of natural density - humidity. As a result of the experiments, we obtain the angle of internal friction φ=〚26〛^0, and the specific adhesion C_II=8.0 kPa. Based on φ=〚26〛^0 according to Table. 4 define dimensionless coefficients M_γ=0.84; M_q=4.37; M_c=6.9 after which we calculate the design soil resistance according to the formula (1)

2. $R = 230{,}90$ кПа;

2. When determining the design resistance when soaking the base, we carry out experiments with soil samples in a water-saturated state and at the same time we obtain the angle of internal friction φ=〚22〛^0 and specific adhesion C=5 kPa. Based on the value φ=〚22〛^0 according to Table. 4 determine the dimensionless coefficients M_γ=0.61; M_q=3.44; M_c=6.04 after which we calculate the design soil resistance R according to the formula (1) R=188.9 kPa;

3. Determination of the design resistance under conditions of long-term water filtration is calculated after determining the strength parameters of the soil after leaching γ_II^1=17.4 kN/m3; C=3 kPa; φ=〚20〛^0. M_γ=0.51; M_q=3.06; M_s=5.66

$R = 172{,}16$ кПа;

II. The base is composed of saline sandy loam, the dimensions of the foundation are l=b=1.5 m, the depth of laying d_1=1.6 18.2 kN\m3 d_b=2 m; coefficients γ_c1=1.1; γ_c2=1; k=1; k_z=1

1. Soil of natural density – moisture = 24^0 , $C = 12$ кПа; $M_\gamma = 0{,}72$; $M_q = 3{,}87$; $M_c = 6{,}48$;

$R = 163{,}35$ кПа;

2. Water-saturated soil $\varphi = 18^0$; $C = 9$ кПа; $M_\gamma = 0{,}43$; $M_q = 2{,}72$; $M_c = 5{,}31$;

$R = 120{,}67$ кПа;

3. Soil leached $\varphi = 16^0$; $C = 7$ кПа; $M_\gamma = 0{,}36$; $M_q = 2{,}43$; $M_c = 5{,}0$;

$R = 110{,}9$ кПа;

III. The base is composed of saline clays. The size of the foundation is l=b= 1.5 m, the depth of the foundation is d_1 = 1.6 m. The specific gravity of the soil in a state of natural density – humidity is 16.7 kn/m3, and the water-saturated and leached γ_II=γ_II^1 =17.2 kn/m3; d_b= 2 m; coefficients y_c1= 1.1; y_c2 =1; k =1; k_z=1;

1. Soil of natural density –humidity $\varphi = 26^0$; $C = 24$ кПа; $M_\gamma = 0{,}84$; $M_q = 4{,}37$; $M_c = 6{,}9$; $R = 93{,}21$ кПа;
2. The soil is water-saturated $\varphi = 22^0$; $C = 18$ кПа; $M_\gamma = 0{,}61$; $M_q = 3{,}44$; $M_c = 6{,}04$; $R = 85{,}6$ кПа;
3. Leached soil $\varphi = 18^0$; $C = 14$ кПа; $M_\gamma = 0{,}43$; $M_q = 2{,}72$; $M_c = 5{,}31$; $R = 77{,}84$ кПа;

The results obtained show that the calculated resistance of the soil of the base, composed, for example, of saline sandy loams after complete water saturation and leaching, is significantly reduced by 1.36-1.48 times compared with the calculated resistance of the soil of natural density –humidity.

Thus, the values of the calculated resistance and the coefficients of reduction of the calculated resistance for different types of saline soils of the base in a state of natural density- humidity, water saturation and leaching were determined experimentally by a single method and summarized in Table 1.

Table 1
The values of the calculated resistance of the base soils (R1,R2,R3) and
the coefficients of reduction of the calculated resistance (K1, K2, K3)

Type of soil	Ground condition			coefficients		
	natures. R_1 кПа	water carrier .R_2 кПа	leaching. R_3 кПа	K_1	K_2	K_3
Sandy loam	163,35	120,67	110,9	0,67	0,74	0,92
Loam	230,90	188,9	172,16	0,75	0,82	0,91
Clay	93,21	85,6	77,84	0,84	0,90	0,93

$$K_1 = \frac{R_{выщ}}{R_{ест}} \qquad K_2 = \frac{R_{еод}}{R_{ест}} \qquad K_3 = \frac{R_{выщ}}{R_{вод}} \quad (2)$$

где, $R_{ест.}$, $R_{вод.}$, $R_{выщ}$ - the calculated resistances of the soil, respectively, in the state of natural density – humidity, after water saturation and leaching.

In general, it is difficult to predict in detail which part of the base will be subject only to humidification, and which to prolonged filtration. Therefore, in engineering calculations, it is recommended, depending on the operating mode of buildings ("dry" or "wet"), in accordance with the requirements of SNiP 2.02.01-83, to consider either complete moistening of the base soils, which leads to subsidence, or prolonged filtration, which leads to suffusion sediment.

1. It is recommended to determine the design characteristics of saline subsidence soils according to three schemes: soil in a state of natural density – humidity: soil in a state of complete water saturation; soil in a state of complete leaching.
2. Water saturation and leaching of saline subsidence soils is recommended to be carried out according to the description in Chapter 2.
3. It is recommended to determine the change in the deformation and strength characteristics of the soil using the proposed coefficients and dependencies, taking into account the physico-chemical properties of the soil.
4. The conditional design resistance of the soil can decrease by 1.36-1.48 times when taking into account long-term water filtration. Under the same conditions, the additional sediment of the foundation increases by 1.0-1.5 times.

References.

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