Geo-Surveys for Railway Electrification

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Abstract. *One of the problems of electrification of desert and semi-desert areas is the weakness of soils and its salinity. In addition, the contact network is affected by fluctuations in air temperature in summer and winter, which have a negative impact on power supply devices. Weak soils require a special approach to the methods of fixing the supports of the contact network, and excessive heating of the wires means the use of wires with good temperature parameters*

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Currently, electrification of railways is being carried out at a high pace in the Republic of Uzbekistan. As is known, the transition to electric traction has a great impact on the ecology of the environment, as the number of diesel-powered trains that emit a large amount of exhaust gases and combustion products into the environment decreases.

Uzbekistan is famous for historical monuments and world-famous ancient cities - Tashkent, Samarkand, Bukhara, Khiva. In order to unite these cities with a comfortable mode of transport, a high-speed railway connection was organized for the convenience of guests and residents of Uzbekistan. High-speed electric trains run between Tashkent, Samarkand and Bukhara. A railway track was built to Khiva, which is currently planned to be electrified.

The location of the railway line passes through the territory of Khorezm, Bukhara regions and the Republic of Karakalpakstan. The railway route passes mainly through the arid areas of the south-western Kyzylkums (Fig. 1). The area is deserted, the territory is undeveloped. The nearest settlements in the district are the settlement of Miskin. Passage through the site is possible only by high-traffic vehicles, which makes it difficult to carry out work.

The problem of electrification of this section is the weakness of the soil and its salinity. The climate of the area is desert-continental, due to the distance from the sea basins, with a large temperature difference at night and day, winter and summer. The air temperature ranges from +40°...+50°With summer and -20°...-30°With winter. In addition, the railway track runs through an open area that is not protected from direct sunlight, which will increase the heating of the contact suspension wires from exposure not only to ambient temperature, but also from solar radiation. That is, weak soils require a special approach to the methods of fixing the poles of the contact lines, and excessive heating of wires means the use of wires with high temperature characteristics.

The relief along the route of the projected railway is a gently sloping low-framed plain of the Southwestern Kyzylkums, complicated by various forms of Aeolian sand accumulations (ridge, bumpy, dune). The height of the dunes reaches 10-12 m. In the depressions, there are takyr formations stacked from the surface with clay soils.

To determine the stability of the poles in weak soils and to develop a method for fixing them, a number of survey works were carried out. The location of the workings, types and volumes of field and laboratory work were carried out in accordance with the requirements of the current regulatory documents of the Republic of Uzbekistan. In accordance with the intended purpose of the work, as well as the current regulations, drilling of wells by the screw method, drilling of wells by the core method with the selection of monoliths in the places of transitions and recesses, drilling of pits manually was carried out at the investigated site.

Soil samples of undisturbed and disturbed structure were taken from screw wells, soil samples of undisturbed structure were taken from core wells, and monoliths of soil from each lithological difference were taken from pits.

To determine the corrosion aggressiveness of soils to carbon steel, of which the reinforcement of poles and foundations consists, measurements of specific electrical resistances were carried out for depths of 1.0 m and 3.0 m every 500 m.

Drilling operations were carried out to study the lithological structure, soil sampling to determine the physical and mechanical properties and occurrence of groundwater. Screw drilling was carried out by a drilling rig of the UKB 12/25 type. Core drilling is carried out by a drilling rig of the URB 2.5 "dry" type. The sinking of the pits was carried out manually, in order to sample the soil of an undisturbed structure.

Fig. 1. The territory of the railway track.

Determination of the electrical resistivity of the soil was performed by a four-electrode Venner installation. Steel electrodes with water filling are used. According to the Norms of Uzbekistan, a complex of geophysical works was carried out, allowing to determine the corrosion aggressiveness of soils at the research sites and the electrical resistance of rocks to a depth of 3.0 m.

The corrosion aggressiveness of soils in relation to carbon and low-alloy steel was estimated by the value of the electrical resistivity of the soil. Measurements were carried out along the route of the projected railway by the Geom device, the Venner installation.

The value of the electrical resistivity of the soil p is calculated by the formula:

$$\rho = 2\pi Ra$$

where R is the resistance measured by the device, Ohms;

a is the distance between the electrodes.

Laboratory methods for determining soil properties were performed to classify soils, assess their condition, physico-mechanical and chemical properties. Chemical analyses of the composition of soils were carried out in order to assess their aggressive properties in relation to concrete and reinforced concrete structures. On the monoliths selected from geological workings, a complex of definitions of physical-mechanical, deformation and strength properties of soils was carried out taking into account the lithological structure of the route.

Due to the lack of water supply sources along the route of the railway line under construction, it is recommended to drill hydrogeological wells every 15-20 km with a depth of 150-200 m. The peculiarities of the physical and geographical conditions of the studied area - arid climate, intense dissection, the absence of permanent watercourses, caused extremely weak waterlogging of rocks. Natural water occurrences are rare and spread unevenly over the area. They are absent in most of the territory.

The anchoring of the poles in weak soils is carried out in such a way that the foundations of the catenary poles in weak soils are arranged so that they rest on a layer of ordinary soils.

To fix the cantilever poles and rigid crossbars in weak soils, the following design solutions are used:

block foundations with a widened shelf (1.3 m) and a base plate (Fig. 2, a): to increase the bearing capacity of such foundations and reduce the freezing depth, a 1 m wide powder is arranged on the field side;

pile foundations made of single piles of struts from 6 to 10 m long, which rest on dense soil located below the weak one (Fig. 2, b);

two-layer foundations with a grillage and hanging piles with a cross-sectional area of 0.3 x 0.3 m and a length of at least 6 m (Fig. 2, c); the lower surface of the grillage should rest on non-loose soils (the body of the roadbed) and have a distance from the top of the weak soil of at least 5 m. Such foundations are used when the lower horizon of weak soils is located at a depth of 10 m or more from the UGR.

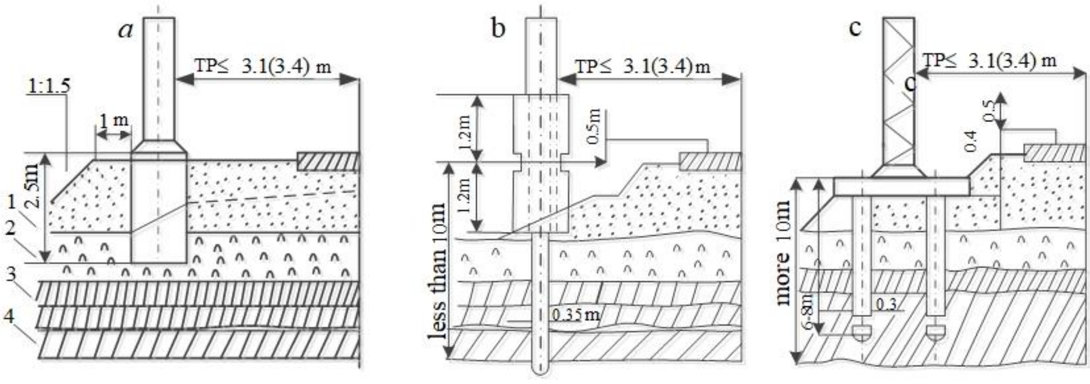

Fig. 2. Methods of fixing the catenary poles in weak soils:

a - block foundation with a widened shelf; *b* - pile-rack with a prefabricated

glass head; *c* - double-pile foundation with a grillage and hanging piles; 1 - powder; 2 - peat; 3 - crust: 4 - clay

Pile foundations are used to install catenary poles on the most unfavorable sections of the roadbed in terms of stability, on embankments located on weak subsidence bases and blocked soils; on embankments composed of heterogeneous weak soils, etc. (Fig. 3).

Fixing the catenary poles in the ground - the foundations (or the foundation part of the poles) are calculated in the same way as the bearing capacity of the poles — by the method of limit states, i.e. by deformations and stability (bearing capacity), at which they cease to meet the requirements of operation.

Foundations are calculated on combinations of loads that may be the most unprofitable, For example, the unprofitable moment may not be the maximum load, but the minimum, but acting in the direction in which the soil is less resistant to overturning the foundation, or the one in which the proportion of constant loads in the total is more important.

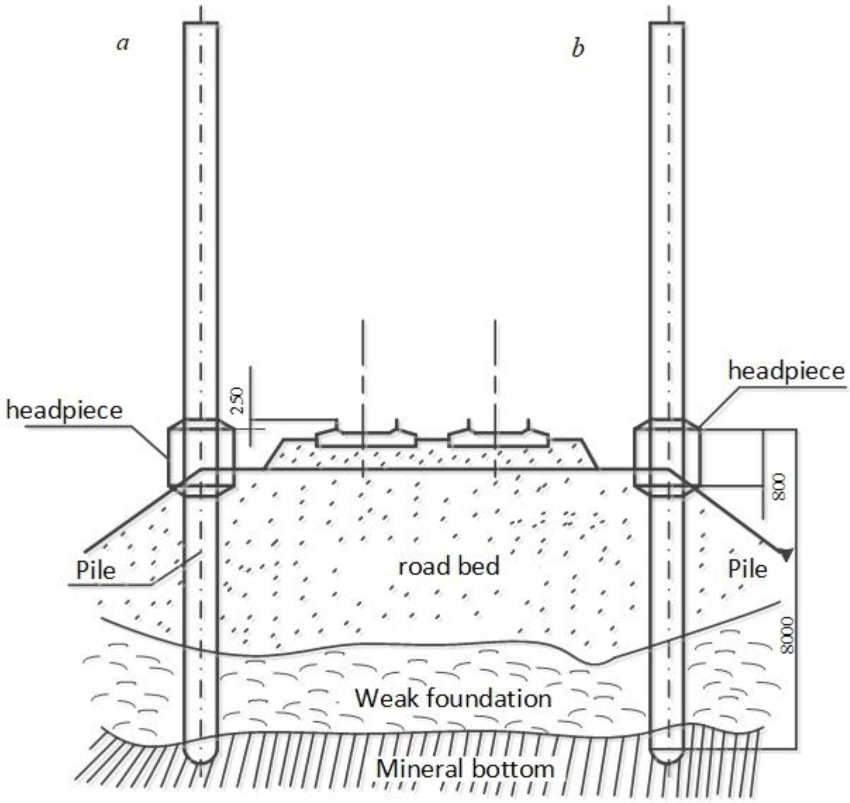

Fig. 2. Installation of the poles of the CSA (a) and MK (b) contact lines on a pile foundation (general view)

In principle, fixing the supports in the ground to ensure the stability of the poles in the ground, the condition must be met:

$M^n_f \leq M^n_{gr}$

where M^n_f is the normative bending moment, kNm, acting on the pole at the level of the UOF across the path under given conditions, but no more than the permissible bending moment M^n for the accepted pole.

M^n_{gr} - standard bending moment, kNm, permissible poles (foundation) according to the conditions of stability in the ground.

Normative moments for various types of soils are calculated at certain parameters of the width of the roadbed, the estimated depth of laying and the share of constant load in the total.

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