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About Some Features of the Foundation Supports of Power Lines

Tsoy Vladimir Mikhailovich [1], *Muxammadiev Ne'matjon Rakhmatovich* [2]

Abstract: The foundation supports of power lines are crucial components in ensuring structural stability and operational reliability. Key features include the capacity to withstand various environmental stresses, such as wind load, soil type, and seismic activity. Recent advancements in materials and design have enabled foundations to improve load-bearing efficiency while reducing environmental impact. This paper discusses the design criteria, construction techniques, and maintenance strategies that enhance the durability and safety of power line foundations, particularly in challenging terrains.

Key words: Power line foundations, Structural stability, Load-bearing capacity, Environmental stresses, Foundation design, Maintenance strategies, Durability, Seismic,resistance, Soil type, Wind load.

The unified composite foundations of the 35-500 kV overhead line poles were developed as a replacement for the series of mushroom-shaped bases 3.407-115 (issues 2 and 3) and received their own series 3.407.1-144 (issue 1) with the name "foundation F". This type of base belongs to the unified ones, as it is produced according to a standard series of drawings with mounting options for supports of different weights and designs. The composite foundation allows for the assembly and installation of the base on site, simplifies transportation and installation due to the possibility of using lighter equipment.

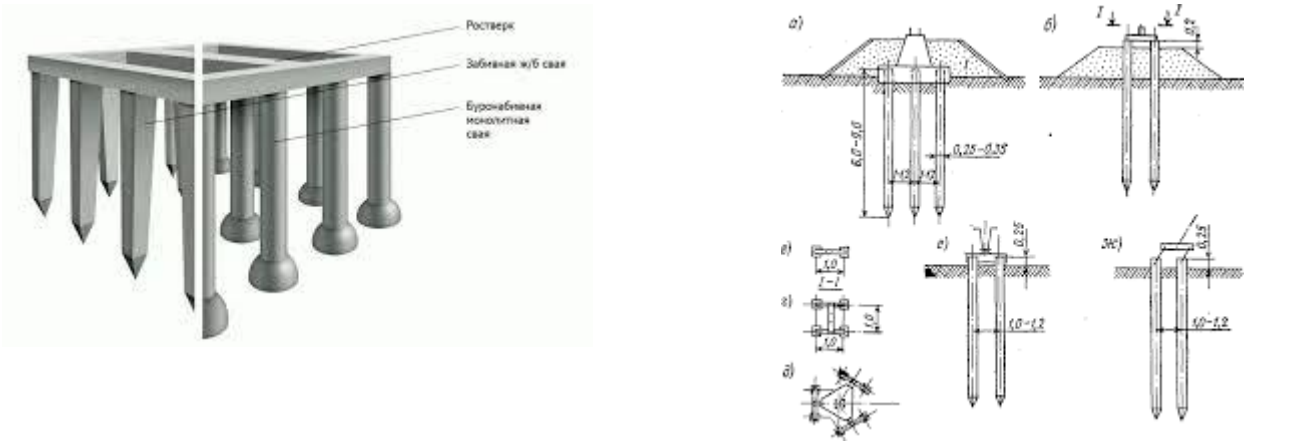

Fig.1. Types of foundations

The scope of application of reinforced concrete foundations for the installation of metal poles of power lines

A unified composite product made of a base plate and a vertical mounting rack is available in several versions. Design differences within the same series of drawings allow the use of a prefabricated base for mounting power transmission line supports with a selection of mounting options:

[1] Prof. Doctor of Technical Sciences, Tashkent State Transport University, Department of Construction of Buildings and Industrial Structures, Doctor of Technical Sciences, Professor

[2] Tashkent State Transport University, Department of Construction of Buildings and Industrial Structures, Candidate of Technical Sciences, Associate Professor

- a rack head with two embedded bolts is used for mounting an intermediate support with a low and medium load of the 35-330 kV overhead line type;
- the head of the rack with four embedded bolts is used for the installation of intermediate and anchor-angular supports of power lines with high operational loads of 35-500 kV overhead lines;
- 500 kV overhead line supports are anchored and angled mounted on the head of a composite foundation pillar with four M42 bolts and a base of 350-400 mm to distribute a significant load.

Depending on the design load and the soil condition of the reinforced concrete, the foundation for the support of the power line can be purchased in versions according to the total area, weight and aspect ratio of the base plate.

Design features of a prefabricated unified foundation for power lines

The foundation structure is a composite solution consisting of a base plate and a vertical mounting rack with mortgages for the installation of the lower part of the support. The slab and the rack are made of concrete with the following characteristics:

- class not lower than B30, brand M350;
- frost resistance of reinforced concrete structures of at least 100 complete cycles;
- for particularly difficult operating conditions, the products are available with a water resistance of W6 and a threshold of full freezing cycles of 150;
- the water resistance of reinforced concrete W4 allows you to mount the foundation with a sinking into the ground.

To impart load-bearing capacity and deformation strength, metal volumetric reinforcement of the plate and the rack with class AII steel in the form of a hot-rolled bar of a periodic profile is used.

Structurally, the foundation plate for the power line supports has a T-section and a stiffener with a recess for mounting the rack. To increase the load-bearing capacity, the base plates have bends in the direction from the rack socket to the edges with ribs. The rack can be released as rectangular, trapezoidal or with a fold.

The product is designed for operation at temperatures up to -30 and -35 degrees. The release of the slab in several standard sizes with different aspect ratios allows you to choose the foundation base depending on the properties of the soil, including for mobile soils and for conditions of location above permafrost. The F-type base is designed for installation in sandy, clay, loamy soils and sandy loam. The depth of the base plate can reach 5 m.

The advantages of using a mushroom-shaped foundation of a power line type .The conditions of installation and operation of power transmission poles dictate specific requirements for reinforced concrete foundations.

1. Complex distribution of the weight load — the power line support acts on the rack, which transmits compression to the plate socket. In this case, additional forces may occur directed along the reinforcement frame, but with a deviation from the vertical axis.
2. Dynamic loads - the power line support is exposed to the wind, so the foundation pillar periodically receives a significant compressive force, and when the wind changes, it breaks.
3. Structural features of the supports - intermediate and anchor-angular supports can create forces in different directions, which requires the foundation to be able to work with different loading profiles.
4. The laying of power lines takes place in difficult conditions with transport and technological constraints.

Taking into account these features, a series of composite foundations for power transmission poles has been developed as unified with a number of structural and operational advantages:

- the prefabricated structure allows you to organize the delivery of foundations by road with optimal placement of parts, plates and racks can be positioned with maximum body filling, platforms;
- the unified solution is designed for the installation of intermediate and anchor-corner supports, this is facilitated by a large number of standard sizes of plates with different aspect ratios;
- foundation slabs and racks with mortgages are made for fixing supports with different loads, when forming a purchase batch, you can focus on foundations of the same series;
- indicators of frost resistance, water resistance and strength of concrete correspond to a wide range of conditions, make it possible to obtain the optimal ratio of stability and load on soils of any type;
- Installation of the foundation of the support under the power line with deepening reduces the risk of rapid wear of the plate and the rack, allows you to find a stable soil base below the freezing depth.

The disadvantages of such an overhead power line foundation include the fact that the installation of this foundation is associated with the risk of damage due to the fact that the concrete is subjected to significant overloads, since the pile is driven into the ground. There is a large acoustic impact on the environment during installation. When interacting with the soil, concrete is corroded.

The developed design of the foundation supports patented under the number No. IAP 7747 the closest technical solution to the invention, i.e. the prototype, is the foundation of the support of the overhead power line [3], made in the form of a round pile with a metal conical tip, the pile is made in the form of a hollow metal cylinder and has an outer screw surface along the entire length, the cavity of the pile it is filled with filler, and holes are made in its upper part for installing fasteners for the support of an overhead power line. The filler is sand or concrete.

However, the disadvantage of the well-known foundation of an overhead power line is its high metal consumption, insufficient corrosion resistance and reliability of the structure.

The objective of the invention is to reduce the metal consumption, prevent corrosion of the metal conical tip and increase the reliability of the foundation.

The task is solved by the fact that in the foundation of the overhead power line support, made in the form of a round pile with a conical tip, which is a hollow metal cylinder having an outer screw surface along its entire length and filled with filler, and in the upper part having holes for installing fasteners of the overhead power line support, as a conical tip material fiber-reinforced concrete is used, precast concrete is used as a filler, and the outer screw surface is available within the entire length of the cylinder.

The essence of the invention is explained by the figure (FIG.1), which shows the foundation of an overhead power line support, made in the form of a pile 1, circular section with a fiber-reinforced concrete conical tip 2, made in the form of a hollow metal cylinder 3 and having an outer screw surface 4 along the entire length of the cylinder, fixed relative to the ground and screwed up to ground level. The pile cavity is made of precast concrete, which is manufactured at the factory. After fixing the foundation at ground level, a support is installed on the foundation using fasteners (not shown in the figure), which are fixed into holes 6. The use of the proposed design of the foundation of the overhead power line support will significantly reduce the metal consumption of the structure, since the metal conical tip is replaced with a fiber-reinforced concrete (the impact strength of fiber concrete is 5-10 times higher than that of conventional), prevent corrosion of the conical tip, since fiber-reinforced concrete, unlike metal, is not subjected to corrosive processes when exposed to groundwater, as well as to increase the reliability of the foundation, since in the process of corrosion of the metal conical tip, loosened corrosion products can form for a long time, which can cause precipitation of the foundation of the overhead power line support.

The foundation of the overhead power line support is installed as follows. A round pile 1 with a fiber-reinforced concrete conical tip 2, made in the form of a hollow metal cylinder 3 and having an outer screw surface 4 along the entire length of the cylinder, is fixed relative to the ground and screwed up to

ground level. Then, a support is installed on the foundation fixed at ground level using fasteners (not shown in the figure), which are fixed in holes 6.

A comparison of the structures of the foundations of the overhead power line support shows that the proposed technical solution reduces the metal consumption of the product manufacturing process (by 40-50%, depending on the length of the pile), prevents corrosion of the conical Accordingly, to increase the reliability of the foundation, completely eliminating the possibility of its precipitation due to corrosion of the conical tip over a long time. In addition, transferring the process of filling the pile cavity with concrete filler to factory conditions can significantly reduce the time and seasonality of installation of overhead power line supports, since this eliminates: a technological break necessary to gain strength of the filler from monolithic concrete laid in the foundation cavity and breaks in the production of concrete works at negative outdoor temperatures.

The foundation of the overhead power line support can be used for supports of overhead power lines of 0.4-110 kV, for guy wires of overhead power lines with a voltage of 110 kV and higher.

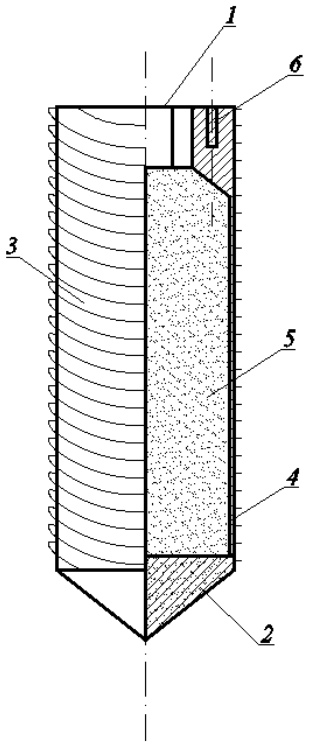

Fig.2. the foundation of the overhead power line support

Conclusions

The foundation of the overhead power line support, made in the form of a round-section pile with a conical tip, which is a hollow metal cylinder having an outer screw surface along its entire length and filled with filler, and in the upper part having holes for installing fasteners of the overhead power line support, o t l and h a y s I mean that fiber concrete is used as the material of the conical tip, precast concrete is used as a filler, and the outer screw surface is available within the entire length of the cylinder.

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