GUY POLYMER CROSS-PIES SUPPORTS FOR OVERHEAD POWER LINES OF DISTRIBUTION NETWORK 35 - 110 kV VOLTAGE

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ABSTRACT

New types of steel supports for distribution overhead lines 35 – 110 kV voltage have been offered. The supports have improved mechanical characteristics, lowered volume of building and mounting operations. The new types of steel supports are used as an emergency reserve support and for construction of overhead lines.

PROBLEM STATEMENT

Tower and pole supports are supposed to be the most widely spread steel structures for distribution overhead lines. Stayed supports are but rarely used. The body and rigid crossarms of such supports are integrated in one framework hinged on the footing and fixed in space by means of stay-guys. Even rarer are structures with a flexible stay crossarm that serves as a main load-carrying member of the support structure.

From our point of view, disregard of the advantages of using supports with flexible stay crossarms in distribution overhead lines is groundless. These supports allow achieving a high performance of distribution overhead lines, besides they are useful as emergency reserve supports to be used when eliminating the breakdowns caused by downfall of supports.

SUPPORT STRUCTURE DESCRIPTION

Fig. 1 gives a support picture and fig.2 gives a support diagram. The support is designated as PO110P. It consists of 2 posts installed on one base and hinged with one degree of freedom in a plane perpendicular to the overhead line axis. The tops of the posts are coupled with a flexible stay polymer crossarm, with overhead lines fixed on the latter. The support is held in a working position by 2 main stay-guys and four emergency stay-guys. The main stay-guys are fixed in soil by any available means – anchor, pile or screw footing. Emergency stay-guys O2 are anchored on one footing together with the support posts. This footing is made of a 30 x 30 cm rectangular pile laid in soil (surface footing). Emergency stay-guys O2, as well as the support posts are hinged on the footing.

The support shown in Fig. 1 has overall dimensions meeting the requirements of the 35-110 kV overhead line voltage grade. For these voltage grades the posts are 15 m long and designed as a space framework formed by 4 carrying main legs made of 40x40x40 mm steel angles which are interconnected by means of strips in every 40 cm. The post has a 0.25x0.25 m section and three segments interconnected with flanged bolts; the mass of each segment not exceeding 110 kg. The total weight of the support equals to 860 kg including segments, fixtures and stay-guys.

The stay crossarm consists of four polymer rod insulators designed for ultimate tensile stress of 12 ton-force. The insulators are interconnected in the stay crossarm by means of adequate line accessories. Two insulators are rated for phase voltage, while the other two – for mesh voltage.

The support with overall dimensions specified in Fig. 1 allows using 120-240 mm^2 wires and 200 – 300 m spans in regions with wind speed of 29-36 m/s and ice deposit from 5 to 20 mm.

Fig. 2 demonstrates a photo of PO110P support mounted in 110 KV overhead lines.

APPLICATION

Primarily, the support in question was designed as an emergency reserve support meant for eliminating breakdowns caused by downfall of supports in hard-to-reach areas. In Russia such areas can be found in a greater part of the Asian territory and northern regions of the European territory. These areas are characterized by a poorly developed network of motor roads, which prevents access of wheeled transport to the crash scene. For the most part of the year, only tracked vehicles or marsh buggies can reach the crash scenes.

Then PO110P supports found their application in construction of overhead lines due to a low mass of supports and simplicity of their anchorage in soil, the advantages that reduce the costs of construction as compared to other supports.

Use of PO110P supports for emergency reserve purposes

PO110P was designed so that during its installation a minimum amount of equipment and no heavy machinery would be involved.

With this aim in view, the fastening assemblies of the support and crossarms are designed so that the support can be fully mounted on ground and raised to a working position by means of a drooping jib of a hand-operated or electric winch. In so doing the support is hoisted together with the wires. Taking in account that the mass of the heaviest segment of the support equals just to 110 kg, dismantling and assembling the support can be carried out manually.

The procedure for assembling the support to be installed in the overhead lines when eliminating the breakdown caused by support downfall is as follows (fig.3):

1. If support downfall has resulted in wire breakage, it is necessary to connect the wires first.
2. A 0.3 x 0.3 m concrete pile is then used to lay a surface footing for the support, which should be oriented along the axis of the overhead line.
3. Footings for fixing the main stay-guys are placed. The simplest method is an anchor which can be screwed in soil manually or by means of a hand-operated gasoline-powered or electrical tool.
4. Supports and assemblies for fastening emergency stay-guys are then mounted on the footing. Also mounted on the footing is the first post stay-guy.
5. A lower segment of the first post is assembled on the support base followed by connection of the middle and upper segments. Emergency stay-guys of the first post are also mounted at this stage.
6. A lower segment of the second post is assembled on the support base followed by connection of the middle and upper segments, with the latter put on the first post. Emergency stay-guys of the second post are also mounted at this stage.
7. A drooping jig is installed. The hoist rope of the winch is brought in the drooping jig and fixed to the top of the second post, also fixed to this top is the main stay-guy.
8. Hoisting the second post starts. After elevating it to a height sufficient to mount the first insulator the hoisting process is stopped. The first insulator and the first wire clamp are mounted to the top of the second post. The first wire is put and fixed in the clamp. The second insulator and the second wire clamp are mounted.
9. Elevation of the second post continues until it becomes possible to put the second wire in the clamp. Hoisting is stopped. The second wire is led in the clamp and fixed in it. The third insulator and the third wire clamp are mounted.
10. The second post is hoisted until it becomes possible to place the third wire into the clamp. Hoisting is stopped. The third wire is put in the clamp and fixed in it. The fourth insulator is mounted.
11. The second post is elevated until it becomes possible to fasten the last insulator on the first post. Hoisting is stopped. The stay crossarm is fixed on the top of the first post. Also fixed at this stage is the main stay-guy.
12. Hoisting the second post is going on. At some point the stay crossarm is stretched, the lifting force is transmitted through the crossarm to the first post and the elevation of the second post commences. The support is brought to a working position prior to stretching of the first post stay-guy.
13. The main stay-guy of the second post is fixed on the footing.
14. The hoisting rope is dismantled.
15. A balanced position of the support in space is provided by adjusting the stay-guys.

The described procedure was tested while modifying BJI 110 overhead lines when the fallen wooden supports were being replaced with PO110P steel ones.

Use of PO110P supports in construction of overhead lines

When constructing new overhead lines on the base of PO110P supports, the procedure used for hoisting a support is similar to that described above, with the only difference that a support is elevated without the wires, which are laid after the supports in an anchor span are installed. Laying PO110P support-based wires when carrying out a new construction project is less suitable, because one has to bring all three wires into the support and mount them by means of a hoisting device. However, a low mass of supports and footings and their low price respectively are responsible for the introduction of PO110P supports into the construction of new overhead lines.

About 200 km of 35/110 kV overhead lines based on PO110P supports have been constructed in the following regions of Russia: Kuzbass, Yakutiya, Khakassiya and the Far East.

No overhead ground-wire cables are provided for in PO110P supports. Nevertheless, lightning-surge proofness of PO110P support-based circuits is within the admissible limits. It can be explained by the fact that all wires on a PO110P support are located in one horizontal plane, not too high overland. This feature reduces the number of lightning strokes, and if constructed in a wooded area, the overhead lines experience an even lesser quantity of strokes because of the wires screened by the surrounding trees, which are typically higher than the wires suspended on a PO110P support. This topic is discussed in detail in [1], the authors of the present report would like to demonstrate some summary data on lightning-surge proofness of 110 kV overhead lines constructed on PO110P supports and standard tower supports (see Tables 1 and 2). As is seen from Table 2, a PO110P support-based overhead line without overhead ground-wire cables is struck by lightning 2.4 times less than a tower-based one with overhead ground-wire cables.

Table 1.
Comparison of overhead line design parameters

Tower type	P110-4	PO110P
Cable suspension height, m	31	-
Cable protection angle, deg.	22	-
Wire suspension height (upper), m	25.7	13.5
Insulation type	Glass	Polymer
Foundation type	pile foundation C-35-1	as per design

Table 2.
Lightning proofness estimates

Nos.	Parameter	Tower type	
		P110-4	PO110P-2
1.	Number of lightning strokes at the line, 1/100 km/100 thunder hours	26.5	9.4
2.	Number of lightning outages, 1/100 km/100 thunder hours:		
	● wire stroke	1.5	9.4
	● cable and tower stroke	21.2	-
	● total	22.7	9.4

A similar procedure can be applied for other supports designed for higher grades of overhead lines, for example 220 kV circuits. In this case it is necessary just to re-estimate the mechanical characteristics of a support.

CONCLUSIONS

1. A new version of PO110P support with a flexible stay polymer crossarm serving as the main load-carrying member of the support structure is developed. This version is meant as an emergency reserve support to be used when eliminating breakdowns caused by support downfall.

2. PO110P supports can be mounted with a minimum quantity of facilities, thus making their use preferable while eliminating the breakdowns caused by support downfall in hard-to-reach areas.

3. A low mass of supports and footings, as well as their low price reduce the costs of construction of PO110P support-based overhead lines as compared to those based on tower/pole supports. These advantages have led to their primary use as the major supports in construction of overhead lines.

4. Even though overhead ground-wire cables are not provided for in these supports, the overhead lines constructed on the latter demonstrate adequate lightning-surge proofness resulting from a low height of wire suspension on the supports.

REFERENCES

[1] A.S. Gaivoronsky, Y.R. Hunger, A.V. Klepikov, E.N. Prokofyeva, 2004, "Lightning Protection Problems for 110 and 220 kV Overhead Lines in Areas with Permafrost Low-conductivity Soils and Methods of solving them", *Proceedings 27th International Conference on Lightning Protection*, Avignon-France, vol.2, 714-719.

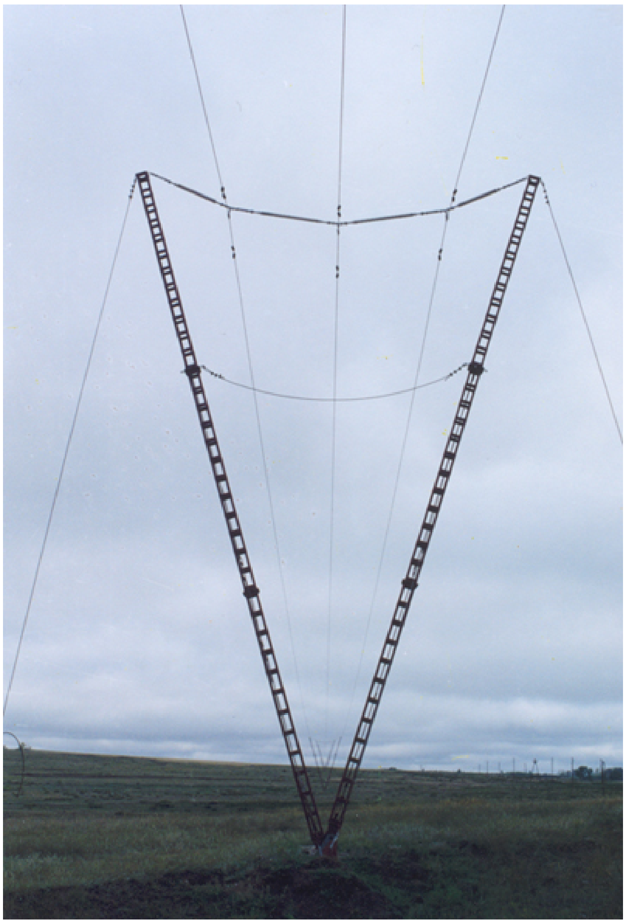

Figure 1. The picture of PO110P support.

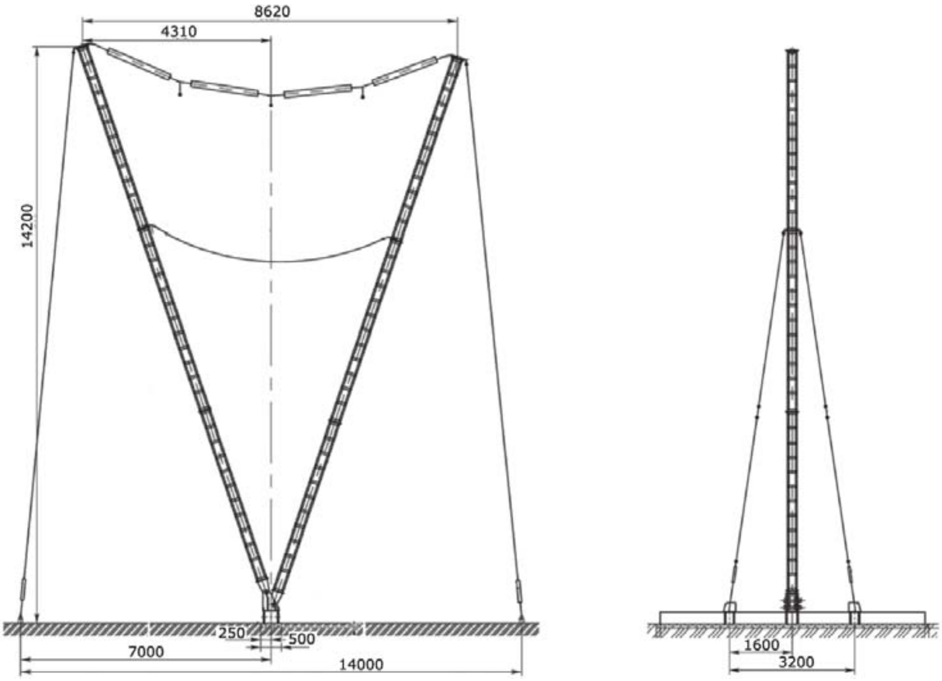

Figure 2. The diagram of PO110P support.

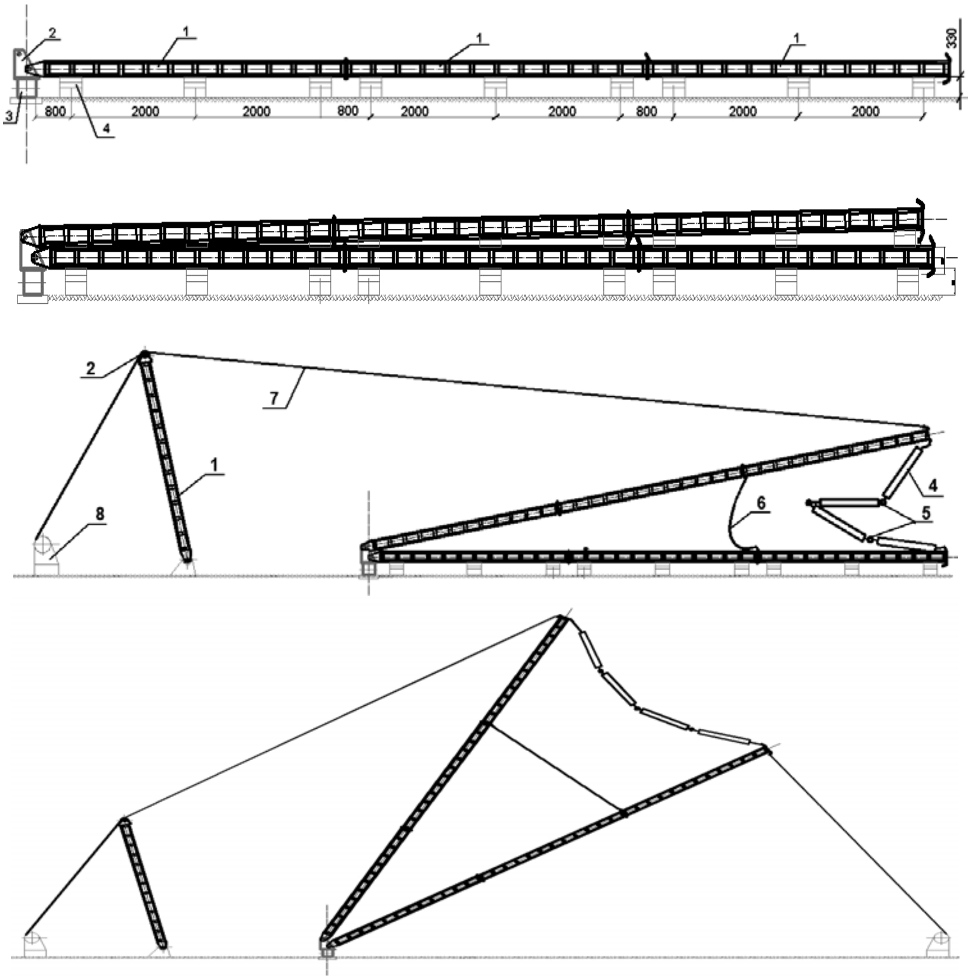

Figure 3. The procedure of assembling the PO110P support.