Technical support of the power lines design - as a linear structure in difficult mountain conditions

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Abstract. The article highlights the process necessary at the present stage of organizing the scientific and technical support of projects for the construction of overhead power lines (OPL) in difficult mountain conditions. The development of mountain areas is associated with overcoming various technical, technological and organizational difficulties, sometimes reducing the expected economic, environmental and social benefits. In order to obtain the maximum effect from the activities carried out during the construction of power lines, the article substantiates the method of scientific and technical support - an expert opinion of a scientist on the safe operation of power lines, which will provide economic and social benefits to society.

1. Introduction

The development of a mountainous area, as the practice of the development of society shows, begins with the construction of a hiking or pack pass and then its improvement to the possibility of transporting materials and structures for the construction of essential facilities for human life. The creation of social and living conditions of a person includes pulling of power lines, water, gas lines, etc.

In the middle of the last century, when the question of connecting the North Caucasus and Transcaucasian energy systems arose, this became possible thanks to the then existing Georgian Military Road.

The location of the power lines along this historic highway did not represent any special interference. Especially in the most pass area in the area of the Cross Pass, where the elevated plateau and relief for the design and construction of high-voltage transmission lines made it possible for the multivariate choice of the direction of the line. In fact, the only problem was the removal of power lines from avalanche-prone areas. Then design organizations, both the North Caucasian and Georgian energy builders and, accordingly, the designers, coped with this problem quite successfully and two powerful North Caucasian and Transcaucasian power systems were looped back. It should be noted that in addressing the issue a particularly difficult area was the Darial Gorge section, where, along with the avalanche hazard, Russian specialists met with conditions for pulling power lines on stone-landslide, landslide and mud-prone areas, so that by the complexity of relief, geological and other conditions, an example of construction Power lines through the Cross Pass in Caucasus is instructive for science and practice.
2. Relevance of the topic.
The stability of the power lines depends on the conditions of its operation. In stable operation of power lines under flat operating conditions, there are no special external influencing factors. Another question is if it is pulled in mountain conditions, where the stability of the operation of power lines is associated with geological, relief and other crushing processes from different slope (surface-exogenous) phenomena. In such conditions, the operation of power transmission lines is a difficult task, requiring tremendous efforts, since the steady state of the society and its social and living conditions are connected with its steady work. Monitoring the sustainability of power lines, the timely elimination of weak "points", preventing outages from winter and natural external factors are important, especially the preservation of social stability [1-9].

On the example of operation of a single power transmission line to South Ossetia, its operators annually encounter cases of avalanche crashes, since power lines in difficult areas are not monitored and there is no scientific and technical support (expertise of unsuccessful technical solutions by scientists or a group of scientists).

3. Essence of the question.
Upon completion of the construction of the Crossing Highway through the Main Caucasus Range along the Roki Pass - Transkam, the question arose of looping up the South portal of the Roki Tunnel and the Dzhava substation with the Sevkavkazenergo electrical networks. For designers it was not worth a lot of energy to find the most advantageous variant of connecting these two points [10-13].

In the course of the construction of the highway, the builders built a "service tractor road" for driving the road equipment from the Northern section to the Southern section through the Magsky Pass, at an absolute height of 2880m. This process of transportation of road equipment was previously carried out by railway through Beslan - Baku - Tbilisi - Tskhinval with a loss of time for almost two weeks. With the laying of the specified tractor road, for example, a bulldozer started working in another construction site after five hours. A clear benefit was achieved [14-16].

In cramped mountain conditions, when any open linear structure - road (iron or automobile) or power transmission lines are under the watchful eye of avalanche mass, mudflow, or other natural phenomena, their protection becomes a difficult issue (Figure 1).

![Power transmission tower designed in a dangerous place.](image)

Figure 1. Power transmission tower designed in a dangerous place.

Earlier, when the importance of the tractor road was settled, the economic, tourist, pasture, operational and other values were called the factors of its necessity, but no one had thought of using it for pulling power lines. This appointment gave her energy builders. The raising and transfer of high-voltage power lines through the Main Caucasian ridge was carried out in the past century for the second time, but this time its absolute height rose higher than 400m. Naturally, the operating conditions of
power lines at such an absolute height presented particular difficulties in the relief and climatic conditions.

The invention itself with respect to the main construction of power transmission towers reached a fantastic development in the practical sense of performance (Figure 2).

![The original fantasy in the construction of power lines.](image)

**Figure 2.** The original fantasy in the construction of power lines.

This is what concerns the plain conditions.

It was mentioned above that in the middle of the last century, designers and builders of high-voltage power lines showed samples of bold engineering solutions for the transfer of wires and the original placement of the power lines themselves on the slopes with the difference in vertical and horizontal lines not seen before at the absolute height of their placement to 2400 m.

During the operation period of power lines in winter conditions, there are often breaks in the spans of wires due to avalanche emissions in areas of power lines that are poorly protected from avalanches. Analysis of the research issue showed that the power lines under consideration was designed and built in summer conditions free from avalanches. Operating conditions in such complex avalanche-hazardous conditions were not sufficiently examined and investigated. The results of the annual winter operation show that 2-3 times the disconnections due to breaks in the winter and avalanche conditions for the operation of power lines, resulting in such an important in economic, strategic, political, social and other values of the object in an unstable state. To all the complex process of operating power lines through the Magsky Pass, it is enriched with the imagination of engineering. In difficult river gorges on the slopes, a method of anchoring of transverse stretch marks was undertaken, on which instead of power transmission towers wires are fixed according to the following scheme (Figure 3) [17-18].
Figure 3. Anchorage sites in difficult mountain conditions.

Here, on the Magsky Pass, for the first time energy builders and designers had to lift power lines to the height of the Magsky Pass of 2880 m.

The considered method is widely used on the Kosar site of the power lines in the Ardon gorge. In order to ensure the safe and uninterrupted operation of power lines through the Magsky Pass, this method should be introduced in particularly complex mountain areas, including the Dzhomagskiy emergency-hazardous area.

Thus, the analysis gives grounds to conclude that the scientific and technical support of the project or expert opinion on the safety of power lines should be carried out at the stage before the construction of power lines, and if it was built earlier (using the example of the Dzhomagskiy site of the Magsky Line), then such scientific and technical support should be implemented immediately in order to ensure its safe operation.

4. Conclusion
Trouble-free and uninterrupted operation of power lines in mountain conditions depends on the creation of safe conditions in the area of its pulling and also on natural and climatic conditions.

Operational monitoring should be carried out continuously, especially in the winter period.

The implementation and organization of scientific and technical support of the design and estimate documentation should be carried out from research and development centers whose performers have the appropriate qualifications.
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