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Design features of transport tunnels in difficult physical-geographical conditions of Kyrgyzstan

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ABSTRACT: The direction choice of highway and railway routes is identified by an arrangement of mountain ridges and their spurs which, as a rule, are watersheds of basins. Depth of tunnel location and its direction are identified with rock properties, massif character, direction and magnitude of the main horizontal stresses. One of the most essential actions for increasing of efficiency of aseismic construction in mountain territories is choice optimization of an area of tunnel transition in mountain district taking into account seismic conditions.

1 INTRODUCTION

Design and construction of roads and railways in mountainous areas requires a number of complex issues. A characteristic feature of the highlands is the excess of mountain peaks above the valleys more than 700 meters. Route selection is determined by the arrangement of ridges and spurs, which are generally watershed basins [1].

When finding the route of roads and railways in difficult mountainous terrain is often necessary to overcome obstacles in the plan – outline and profile – altitude. To outline actions obstacles include areas of landslides, rockslides, avalanches and snow drifts watercourses. By altitude – all forms of surface relief, which influence the location of the route, that is mountain ranges and watersheds in the process of finding deep tunnels need to solve the following tasks based on features of the highlands [2, 3, 4, 5]:

- study the properties of rocks;
- the establishment of a rational route and depth of emplacement, as well as the configuration of the tunnel, revealing the depth and nature of the weathering of rocks;
- detection of discontinuities places rocks and unusual structures in alluvial deposits;
- the study of the nature and propagation of cracks and their orientation in the rocks;
- determination of pressure rocks and water regime sources;
- assess the impact of factors related to the tunnel works and dewatering;
- identification of the probability of loss or sediment surface slope stability as a result of exposure of the workings or surface drainage;
- establishment of the stress state of rocks, the influence of the seismic action;
- determination of the presence and degree of gas concentration.

Information on the material composition of crush zones, the degree of their fragmentation and watering includes as essential components of the data on which to assess the degree of tectonic disturbances, tensions predict rocks. So, near the heavily fragmented, flooded areas with a high degree of fracture according to instrumental measurements observed a steady decline in strength values compared to background characteristics. In order to quickly get the information needed to assess the strength of rocks in zones of tectonic fragmentation, the study can be completed constructions dimensions on landscape maps in conjunction with geological and geophysical data.

2 RESEARCH

Tunnels can be the most appropriate solution in technical and economic terms, in the case of crossing powerful landslides and rockslides, avalanche-prone areas, large rivers and reservoirs. Crossing landslide tunnel located in the zone of stable rocks, economical than the flyover, if the power slump masses more than 5 m at high power talus characteristic rocky slopes steeper than 30°–35°, composed of fractured rock weathering, most appropriate tunnel crossing scree or in some – cloister.

At crossing of short and abrupt exits of rocky breeds on valley areas of roads in mountain district, and also on passing areas tunnels are laid [6, 7, 8, 9].

In the rugged terrain at high winding valley, high passes, slope processes developed the most rational solution safe construction and operation of the road is a tunnel junction. Tunnel design options of the new road are difficult to determine. Depth of the tunnel and its direction is determined, primarily, rock properties and the properties of the massif, the direction and magnitude of the principal horizontal stress. Tunnel options should be studied very carefully, as the right choice mark the tunnel can reduce the length and amount overcomes a height of the line.

When finding the saddle tunnel route could be considered his two main options: vertex and plantar. The first cuts a mountain range in the upper part and requires significant development approaches and gentle ascents; a second light when it approaches the length and flat head. Vertex is always shorter plantar tunnel, but the total length of the route and overcomes a height in this case anymore. Thus, for the route from the vertex to tunnel compared with plantar characteristic relative decrease construction costs and increase maintenance costs. Joint consideration of these indicators will allow to properly assessing the options being compared.

Selecting a location for the tunnels, the assessment of possible slopes on both sides with the identification methods and convenient locations for the development of the line defined by the terrain, the geological features of the territory, tectonic activity, which is manifested in the form of faults.

Keep in mind that not every fault is dangerous for the construction of tunnels. There are many cases when the power to overcome significant zones of crushing rock and semi rocks, and the penetration rate was high. However, the experience shows that when a zone of tectonic crushing filled with water-saturated rocks, the probability of accidents is maximized. The latter not only depend on the thickness of the zone of fragmentation, stretching and breaking the order, but also determined geotechnical characters rocks. Particular attention should be paid to the displacements along the fault, which may eventually lead to the destruction of the road.

Studies conducted on a number of sites within the Fergana ridge suggests that the magnitude and direction of the resultant rock pressure largely vary depending on many characteristics of faults, including depth, the degree of opening, width, length tectonic zone the nature and kinematics along the zone (effluent, shear, obduct, etc.), their intensity [10,11].

Based on years of observations is revealed that the horizontal displacements along the fault displacement speed should not exceed 10 -4 m per year. At vertical displacements along the fault during the construction of tunnels must be accompanied by special pavement structure.

Selecting a location for the tunnel transition in the highlands subject to seismic conditions is one of the most important activities to improve earthquake-resistant construction in mountainous areas and it often plays a greater role than the aggregate of all other proposed and recommended actions.

The main condition to ensure reliable operation of transport tunnels in seismic regions highlands is a comprehensive account planning, calculation and design principles and solutions to rational economic positions to create the design workable in terms of possible concussions tunnel structure.

Design of transport deep tunnels under seismic conditions can be represented by the following sequence:

- establishing a highly probable security calculated on the basis of seismic trace s seismic-microzoning specific crossover sites;
- informed choice from a variety of options for the tunnel crossing, providing its location in the most favorable seismically in difficult geological conditions;
- appointment of the estimated seismic resistance of the individual elements of the complex tunnel transition based on the importance of objects, their depth of emplacement. These issues are regulated by the instruction on accounting VSN 193-81 seismic influences in the design of mountain transport tunnels; selection of the general scheme of the system and the tunnel and approaches its layout and purpose of general sizes taking into account the requirements of seismic resistance;
- calculation of the basic lining of seismic loads, setting up cross-sections, the definition of seismic stresses in the rock mass;
- do not include tunnels shorter than 200 m in not rocky characterized mobility soils, especially saturated; device to avoid tunnels in areas of tectonic fractures and landslides in the strata of the mountain slopes; design depth of the tunnels in not rocky soil not less than 30 m, measured from the top of the lining; provide for protection of the tunnel portals and the approach it from the recesses of landslides by releasing portions adjacent slopes of hillsides unstable land masses and to consider protection from water saturation not rocky rocks at the location of tunnels at a depth of less than 50 m;

Proper selection of the tunnel transition in favorable geotechnical conditions in the construction of transport deep tunnels in many cases can lead to a decrease in seismic construction site 1–2 points compared to the original seismic area as a whole. Accordingly, to the same extent and the estimated seismic resistance decreases deep tunnels.

In favorable geotechnical conditions changing the nature of the seismic action: eliminating or mitigating the negative effects of tectonic disturbances, secondary residual effects in the soil. Thereby possibly eliminating those factors seismic action with which to fight the hardest settlement and constructive activities.

Predicting areas of high tension rocks at the design stage can provide substantial help in planning the necessary measures to ensure the safety and selection of the optimal technology penetration.

3 RESEARCH RESULT

As an example the description of a route of the transport tunnel on one of deposits of Kyrgyzstan is given.

Table 1. Strength and deformative properties of basic rocks on the tunnel route.

Names of rocks	Strength properties of rock					Deformative properties of properties		
	Rock strength, MPa			angle of internal friction φ, degree	Cohesion C, MPa	Poisson's ratio	modulus of elasticity E_e, MPa	modulus of deformation E_{def}, MPa
	at tension σ_t	at compression σ_{com}	at displacement τ_{dis}					
Quartz-carbonate, fissured metasomatits	7.17	179.37	90.85	43	4.75	0.234	21943.15	13538.92
Massive migmatite and crushed gneissic	4.45	111.25	57.79	43	4.39	0.230	20211.91	12430.32

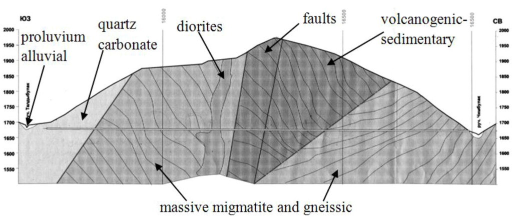

Figure 1. Line of designing transport tunnel.

Designing transport tunnel with the length of 1300 m passes in difficult mountain-geological conditions, crossing two water-bearing faults (Fig. 1).

The main metamorphic rocks are represented by migmatites and quartz-carbonate metasomatic rocks and volcanic sediments. Strength and deformation properties of rocks are given in Table 1.

4 CONCLUSION

1. At the designing of transport tunnels in difficult physical-geographical conditions the site selection are determined by relief zones, geological features, tectonisms and seismic conditions.
2. Optimization of location selection tunnel transition in the highlands considering seismic conditions is one of the most important activities to improve earthquake-resistant construction in mountainous areas and is often plays a greater role than the aggregate of all other proposed and recommended actions.

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