Behavior of the Support Made of Concrete Grades B25 and B35, in the Conditions of Disturbed Ground Rocks

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Abstract. When building underground structures in difficult mining and geological conditions, there is always a question of comparing the price and quality of the materials used. During the construction of underground structures in complex geological conditions. The purpose of this article is to select concrete for lining, which will meet the optimal technical and economic parameters in the conditions of disturbed ground rocks in the South of Kazakhstan.

1. Introduction
The construction of underground structures in difficult geological conditions is a complex technical and economic task. One of the main stages of construction is the choice of lining materials for underground structures, in particular concrete of various grades. This article analyzed various types of concrete, their behavior, as well as the optimal choice for a tunnel in the south of Kazakhstan in difficult mining and geological conditions.

2. Materials and research methods
The mountain range of the proposed construction of the tunnel belongs to the category of very unstable rocks, which are characterized by the collapse of the rock mass following the exposure of the roof of the mining. Rocks are represented by clays composing a disturbed ground mass of rocks, classified as 1-2 categories on the scale of Professor Protodiakonov, the deformation modulus of 1.5 MPa, Poisson's ratio 0.45, lateral pressure coefficient 0.81, the volume weight of rocks 20 kN/m³.

To carry out a tunnel in such conditions, it is necessary to choose concrete that ensures the stability of the mining operation at a minimum cost. As a result of the analysis of existing concrete grades, we choose B25 and B35 for comparison.

The choice of the optimal concrete grade for the tunnel lining was carried out by mathematical modeling using the RC1 program, which allows calculating the load of the array on the tunnel lining structure. The initial data was taken as a circular tunnel laid at a depth of 75 m with a radius of 12 m. To select the optimal lining material, B25 concretes with a deformation modulus of 12.75 MPa were studied and compared according to technical and economic indicators. and mark B35, with a deformation modulus of 14.65 PA. The Poisson module of the lining 0.2.
3. Researches and results

As a result of modeling the underground structure under the specified conditions, the dependence of the load of the array on the inner contour of the lining on its thickness was obtained. The maximum load exerted by the array on the lining is concentrated on the inner contour of the production, for this reason, the load value is used on the inner, and not on the outer contour. The obtained diagrams of the work of the lining of concrete grades B25 and B35 in the specified conditions are shown in Fig. 1 and Fig. 2, respectively.

The tunnel lining begins to collapse when the concrete strength limit is exceeded, so to ensure long-term operation of the tunnel, a thickness of the concrete lining is designed that will ensure its necessary strength and stability in the conditions of mountain pressure from the massif. Thus, looking at the diagrams, you can see the different load of the mountain range on the lining. The modulus of deformation of concrete B35 is higher, therefore, the array loads the lining made of this material more than concrete B25.

![Graph of the load dependence on the inner contour of the workings, on the thickness of concrete B25.](image)

**Figure 1.** Graph of the load dependence on the inner contour of the workings, on the thickness of concrete B25.
Essence of the effect is the following: when the drop is putted on plate, heated to Leidenfrost’s point temperature, it will evaporating gradually. It’s connected with vapor formation of drop as a result of contact of drop and heated plate.

Considering the obtained graphs, you can see that with an equal thickness of the lining, the concrete of the B35 brand will behave more steadily, despite the fact that its elastic modulus is higher and the array loads the lining of the workings more strongly.

Based on Fig. 1, it can be concluded that the thickness of the lining made of B25 concrete, equal to 0.45 m, provides a stable state of development, since the ultimate strength of the concrete is higher than the maximum loads on the lining. Calculating the cost of materials and works for the construction of a monolithic concrete lining of the B25 brand, 970.69 rubles are spent per 1 m3. The cost to ensure the stability of the mine at a thickness of 1 m will be 16.3 m3 of concrete at a cost of 15,842 rubles. In this case, the maximum value of the concrete strength limit is 14.5 MPa.

Going to Fig. 2 it can be determined that for the safe operation of the structure, a lining thickness of 0.3 m should be used. The cost of 1 m3 of concrete is 1125.65 rubles, and for concreting 1 m of production 12 406 rubles. At the same time, the concrete strength index is 19.5 MPa.

4. Conclusion

Based on all of the above, it can be concluded that the use of cheaper concrete B25 is economically impractical, since the volume of B35 concrete required to ensure the stable condition of the tunnel is 32% less. As a result, the total cost of constructing a concrete lining of this brand is reduced by 21%. It should also be noted that B35 concrete is better than its counterpart not only from an economic point of view, but also from a technical point of view, as its ultimate strength is 32% higher. Thus, the use of concrete grade B35 for the construction of a tunnel length of 2000 m will result in an economic effect of 6,920,000 rubles.
5. References

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