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BOUNDARY CONDITION OF THE MINING SUPPORT ON AN EXAMPLE OF THE ARC-INFLEXIBLE SUPPORT**

Abstract

Underground structures and tunnels as buildings cover a wide range of the areas in constructions that are closely intertwined and mutually conditioned. The geological environment conditions are a choice of excavation technology, which in turn indirectly affect the pressure level of rock mass and the choice of supporting structure (temporary and permanent).

Calculation for the support metal elements capacity is presented in this paper.

Keywords: *limit state, metal support units, exploitation demands*

1 INTRODUCTION

By the boundary state of the support is meant the stress state at which the support loses its functionality, i.e. no longer meets the exploitation requirements. Two groups of boundary conditions have been adopted:

- The first group is based on the bearing capacity of the support,
- The second group is based on technological functionality.

Calculation of the support according to the first group of the limit state is carried out on the calculated load taking into account the calculated resistance of material and aims to prevent the loss of structure stability, and thus the support collapse.

Calculation of the support according to the second group of boundary condition is carried out on the normative load taking into account the normative resistances of material and aims to prevent the excessive deformations and displacements of structure and thus ensure the crack stability and limit the width of open cracks.

The calculated limit state of the support is selected in cooperation with the exploitation, technological and techno-economic requirements.

The boundary state of the cross section of support corresponds to the transition from one state to another and quantitatively characterizes the limit values of internal forces, which the cross section of support accepts in this or that transition stage.

At the same time, the limit value of internal forces is related to the certain dependencies on the basis of which the support material, shape and dimensions of the cross section are chosen.

It must be always kept in mind the knowledge gained from experience that the appearance of boundary condition in one or several sections does not always lead to the exploitation exhaustion of su-

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pport. Thus, the appearance of cracks in a cross section of support and joint plasticity prolongs the service life of support.

Calculation of the boundary condition of the support depends on a number of factors, such as: the requirement of an underground room, its duration, degree of importance of the object (whether it is a capital or a temporary facility), etc. The starting point is that the maximum load that the support can receive corresponds to the first boundary state and determines its bearing capacity. For a substructure in which we do not allow the occurrence of cracks or whose radial displacement is limited, the calculated limited state precedes the occurrence of the first boundary state.

As a rule, the first boundary condition of support is preceded by the occurrence of boundary condition in one or several of its sections and therefore it is necessary to determine the qualitative criterion for determining the limit state of the section and appropriate transition from one stage of operation to another, the emergence of these boundary conditions.

An example of calculation and boundary conditions for an arch support will be described below.

2 CALCULATION FOR THE STEEL ARCHED RIGID SUPPORT

The steel arched rigid support is a bent girder with two joints loaded with a continuous load.

This construction (curved rod with two joints) is considered to be a statically indeterminate system. The method by which it will be solved is the method of force.

$$\delta_{11} \cdot X_1 + \Delta_{1p} = 0 \qquad (1)$$

from which is got:

$$X_1 = -\frac{\Delta_{1p}}{\delta_{11}} \qquad (2)$$

Unit displacements Δ_{1p} and δ_{11} are determined without the participation of a horizontal force, by equations for:

- Displacement caused by unit force

$$\delta_{11} = \int_A^E \frac{\left(M_1^0\right)^2 \cdot dS}{E \cdot I} + \int_A^E \frac{\left(N_1^0\right)^2 \cdot dS}{E \cdot F} \qquad (3)$$

- Displacement from external load:

$$\Delta_{1p} = \int_A^E \frac{M_p M_1^0 \cdot dS}{E \cdot I} + \int_A^E \frac{N_p N_1^0 \cdot dS}{E \cdot F} \qquad (4)$$

1. Displacement caused by the unit force (δ_{11})

In determination the unit displacement, the system is loaded by the unit force $X_1 = 1$. Parameters that have to be determined are the unit moment M_1^0 and unit axial force N_1^0. The final equation for δ_{11} is:

$$\delta_{11} = \frac{1}{E \cdot I} \cdot \left[\frac{2}{3} \cdot h^3 + r \cdot h \cdot (\pi \cdot h + 4 \cdot r) + \frac{\pi \cdot r}{2}\left(r^2 + \frac{I}{F}\right)\right] \qquad (5)$$

where:

- E is a modulus of elasticity for steel,
- I is a moment of inertia of the girder profile,
- F is a cross-sectional area of the girder profile.

2. Displacement from the external load (Δ_{1p})

For determination the unit displacement, the system observed under its external influence has calculated the bending moment M_p and normal force N_p. Equation for Δ_{1p} is:

$$\Delta_{1p} = \frac{2}{E \cdot I}\int_0^h \frac{1}{6} \cdot (3 \cdot q_{h2} - K \cdot x) \cdot x^3 \cdot dx$$
$$+ \frac{2}{E \cdot I}\int_0^{\frac{\pi}{2}} \Big\{ R_A \cdot r \cdot (1 - sin\varphi) - \frac{1}{2} \cdot q_v \cdot r^2 (1 - sin\varphi)^2 - \frac{1}{6}$$
$$\cdot [2 \cdot (K_1 - K_2 \cdot r \cdot cos\varphi) + q_{h2}] \cdot (h + r \cdot cos\varphi)^2 \Big\} \cdot (h + r \cdot cos\varphi) \cdot r \cdot d\varphi$$
$$+ \frac{2}{E \cdot F}\int_0^{\frac{\pi}{2}} \Big\{ \Big[q_v \cdot r \cdot sin^2\varphi + \frac{1}{2} \cdot (q_{h2} + K_1 + K_2 \cdot r \cdot cos\varphi)$$
$$\cdot (h + r \cdot cos\varphi) \Big] cos\varphi \Big\} \cdot cos\varphi r d\varphi$$

Figure 1 shows a schematic representation of the two-joint support arcless.

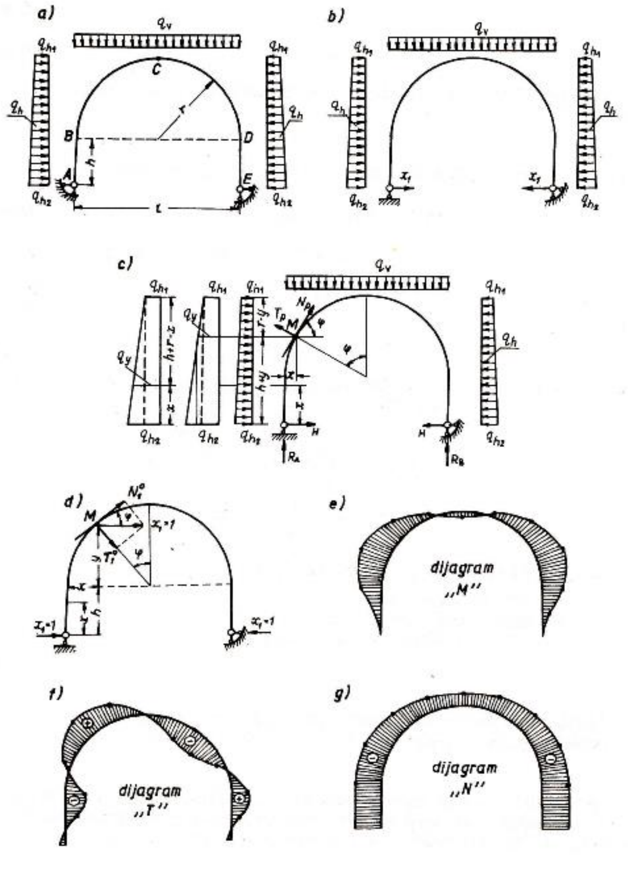

Figure 1 *Schematic representation of the two-joint support arcless*

CONCLUSION

As already mentioned, the condition of support and its functionality, i.e. the satisfaction of exploitation requirements, is of a great importance for the normal operation of mines with the underground exploitation. For that reason, it is important to determine its limit stress state, i.e. the stress state of the metal elements of support, in order to prevent the loss of its stability, and thus its failure. It is also important to take into account the normative resistances of materials that is aimed to prevent the occurrence of excessive deformations and displacements of structures, and thus provide the crack stability and limit the width of open cracks.

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