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Application of Numerical Methods for Strength Analysis of Underground Chambers

The development of the national industry is based on the consumption of mineral raw materials. It leads to the increase of the mining operations. Thus, the number of the holes within the Earth crust is also increased. The use of these holes could help to solve some ecological problems and utilize land resources more effectively. Underground space can be used for location of a great number of mining enterprises, for instance, dressing mills as well for the constructions in the big cities (factories, plants, garages, parking facilities, public utility companies, ware houses, refrigerators, storage facilities etc).

Strike length of Kremenchug iron-ore deposit is almost 50km. Its thickness is 300-600m and its incidence is vertical roughly. Chambers are at the depth of 950m. Breaking compressive ore stress is 90MPa, and tensile stress is 13.4MPa.

Stress calculation of chambers of Kremenchug iron-ore deposit involved finite element method. Area under analysis was divided into finite-size components interrelating through contiguous node points. Data concerning the system structure, types of finite elements, places of application, load rate, and boundary conditions are initial information. Stress values in the centre of gravity of each component are a result of the calculations.

Compression stress within walls of the chamber was 44 MPa; hence, strength margin of the walls is 2.1. Stress in the central part of a span is 2.47MPa at the height of 0.5m from roof; safety margin in a roof is 5.3. The results meet the requirements of creep-rupture properties of the structure. That makes it possible to reuse chambers having such dimensions.

The use of finite element method and a potential helped obtain components of stress-strain state σ_x, σ_y, τ_{xy} within every set point around the chambers.

The results show that increase in distance from the roof contour is proportional to increase in safety margin. The research made it possible to validate results obtained with the help of numerical methods of elasticity theory.

In this context, the results of safety margin obtained according to maximum-stress theory and according to Mohr's theory of failure in a roof differ insignificantly. Within walls of chambers, maximum-stress theory gives less safety margin. Thus, in the context of accuracy being sufficient for practice it is possible to evaluate strength of central part of a roof as well as walls according to maximum-stress theory.