Abstract of the doctoral dissertation

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Determination of the load bearing capacity fir stell arch support covered with shotcrete

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Polish hard coal mines use numerous kilometers of underground workings that were driven several decades earlier. The steel support of these workings is most often highly corroded, and ensuring their stability is a very important duty for maintaining the functionality of the workings and the safety of mining crews. The most popular way to strengthen a corroded support is to strengthen it with a shotcrete coating. Then a combined lining is created in the form of steel arches covered with shotcrete. The selection of the geometric parameters of the coating and the mechanical parameters of the concrete used is crucial for the proper reinforcement of the lining while minimizing labor and material costs. However, there are no guidelines allowing for the selection of coating parameters, based on underground tests of combined supports carried out in mine conditions. This paper presents the course and results of research of combined supports (steel supports covered with shotcrete) carried out *in situ*, computer simulations and laboratory tests of materials and components of the support.

The first, but very important issue was to determine the performance characteristics of the corroded friction joints obtained as a result of the reconstruction of the working. The tests showed that the strongly corroded frame support behaves as firm, and the bearing capacity of the single frame support is limited by the strength of the arches, and not the bearing capacity of the friction joints. This is due to the corrosive, rigid connection of the arcs supports in the overlap. Therefore, there is no conflict between the nature of the work of the rigid shotcrete coating and the door frame - initially flexible, and then stiffened by corrosion of friction joints.

The next cycle of tests were load-bearing tests of the frame supports covered with a shotcrete coating. Various support variants were taken into account, including the most commonly used shotcrete thicknesses and materials. The purpose of these tests was to

determine the bearing capacity of the combined supports and to obtain data for the calibration of numerical models. To determine the actual parameters of the material used for spraying, a whole series of laboratory tests was carried out, and to determine the parameters of the applied coating, field tests were carried out in the pit. Carrying out the tests of the bearing capacity of the combined supports required the development and construction of a loading system that would allow for the generation of forces with significant values. This system, together with the measuring system, is presented in Chapter 4. As a result of the performed tests, the load-bearing capacity of five variants of the combined supports was estimated.

The mapping of the underground tests was the first part of the strength analysis carried out using the finite element method. These simulations, in conjunction with field tests, made it possible to estimate the load-bearing capacity of the combined supports due to the strength of the steel frame supports and the strength of shotcrete. In addition, the form of numerical models, boundary conditions, the method of support and loading have been defined, allowing the satisfactory representation of the behavior of the lining found during underground tests.

The key issue was to determine the load-bearing capacity of the selected variants of the combined supports. These variants included various thicknesses of shotcrete coating (from 5 to 25 cm), different spacing of the frame support (0.50, 0.75 and 1.00 m) and different modulus of concrete elasticity (10, 15, 20 and 30 GPa). The obtained stress values in the models were compared to the selected values of the strength criteria for steel and for shotcrete. As a result, the load-bearing capacity of the combined supports was achieved depending on the mechanical parameters of steel and concrete as well as the geometric parameters of the lining.

The conducted research shows that the variables adopted in the models of the support - mechanical parameters of steel and concrete as well as the spacing of the support and the thickness of the coating significantly affect the resulting bearing capacity of the entire system. The obtained values of the bearing capacity can be used in the selection of parameters of the reinforcing shell of the support frame, as well as in further analyzes and underground tests, allowing for the verification of the obtained relationships and their possible expansion.