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METHOD FOR DRIFTING THE HEADINGS WITH RELIABLE RESERVED SUPPORT

Design complexity of underground objects lays in impossibility of precise determination of value and distribution of existing loads along the heading. It has stochastic nature that is stipulated by changeability and insufficient study of rock massif. Nowadays the headings along all its length as a rule are supported by one kind of support regardless of possible mining-geological conditions changes. Extent of certain permanent workings is within kilometers though strength and deformation surrounded of passed rocks can change greatly even within one lithologic differential. That causes the irregularity of heading convergence along its length. As the analysis shows [3] supporting all headings with high operational reliability is not economically reasonable. The approach, which proposes less expensive support is appeared to be more efficient, that afterwards supposes the separate out-of stable sites of workings can be re-supported and strengthened. In work [7] it is developed the model of stability of extensive heading concerning the operational expenses which allow optimizing cycles of repair works and minimizing the cost of its keeping.

But for heading with high functional reliability the periodic repair of support and accordingly transport down-time are not acceptable.

A support with regulated resistance presents another conceptual approach that proposes the initial support of heading with minimum acceptable bearing capacity of support and its following strengthening with additional structures. But passive expecting for reveals of rock pressure and then providing the set of technical operations to eliminate the negative effects of this can not be used effectively in workings of coal mines with high operational reliability [1, 5].

To decrease the volume of re-supporting and effective use of materials consumption of support in difficult hard predicted conditions Donbass State Technical University has developed the method for keeping mining workings with controlled reserving of support reliability [4]. Reservation principle has found the wide application in the engineering in the form of different load factors (time of failure etc.) and can be introduced like method for incre-

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asing the reliability of the object by including the redundancy i.e. additional means except minimum required that necessary for performing given functions of the object. The aim of reservation is to prevent an object's failure at possible declination of factors influencing from prognosis values.

Method includes simultaneous erection of permanent and temporary support, control for working state and control for bearing capacity, though initially the heading is supported with safety factor. Exceeding the expected load level onto the value of bearing capacity of temporary support, and after realization of displacement of rock contour, if underloaded state of support is determined, there is made the reduction of weight of its structure by step-by-step disassembling the parts of temporary support.

As temporary support it is reasonable to use the steel-frame one. Due to wide range of sizes from (SVP-17 to SVP-33) and opportunity to change the increment of frames (from 0.3 to 1.2 m) it is possible to provide the required reserve of bearing capacity within 0.05 to 0.27 MPa. Assembling (disassembling) simplicity and opportunity of multiple usages also stimulate the priority of steel-frame structures.

As permanent it is reasonable to use progressive structures of roof bolting, concrete lining, rock-bearing (like "Monolit") supports and their combinations. In separate cases steel-frame support can be used as permanent and temporary ones simultaneously (due to increasing the increment).

This method functions as follows. The permanent support is designed according to standard recommendations for these or those mining-geological conditions. Probable deflection of real conditions from a project is considered by probabilistic prognose when working support conditions become worse.

Statistical data can be used for accounting the deflections, which generalize the operational experience of workings in the same conditions and probabilistic methods of their processing (particularly a theory of casual functions). Great value for estimation the changes in geomechanical situation can provide penetrometrical measurements of strength properties of the massif and introscopic research of mine rocks, which are to be made in close to projected workings and in the area of its setting [6]. On the base of prognostication of unfavorable load changes onto permanent support the parameters of additional support are calculated: type of special profile SVP and support advance.

While heading is being drifted it is supported simultaneously with permanent and temporary or additional support. Effective element of interaction of permanent and temporary supports can be fabric sleeves (like "Bullfex"), filled by the solidifying composite solution. At this condition placing the sleeves "Bullfex" over the frames perimeter provides rapid introduction the structure into operation and as well as united with permanent support counteraction to rock pressure. For the same purposes in workings with rectangular section an advance thrust of support elements can successfully be applied [2].

In fixed working it is stipulated to install surveying stations. Watching for rocks movements and for state of main support frames is carried out during 6 months (a realization period of main displacement of rock contour).

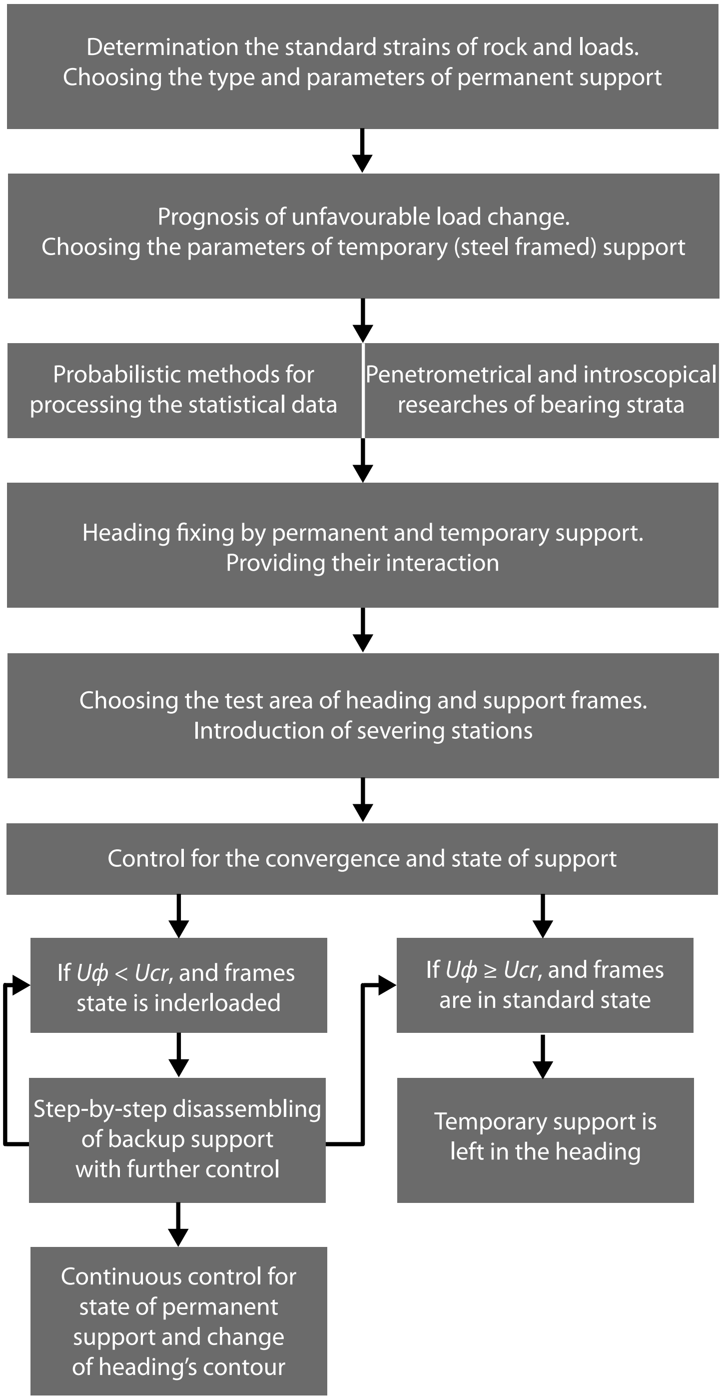
Determination the standard strains of rock and loads.
Choosing the type and parameters of permanent support
Prognosis of unfavourable load change.
Choosing the parameters of temporary (steel framed) support
Probabilistic methods for processing the statistical data
Penetrometrical and introscopical researches of bearing strata
Heading fixing by permanent and temporary support.
Providing their interaction
Choosing the test area of heading and support frames.
Introduction of severing stations
Control for the convergence and state of support
If Uф < Ucr, and frames state is inderloaded
If Uф ≥ Ucr, and frames are in standard state
Step-by-step disassembling of backup support with further control
Temporary support is left in the heading
Continuous control for state of permanent support and change of heading's contour

Fig. 1.

On the base of developed criteria of frame support state one can evaluate its working ability and if underloaded state of structure is revealed then take decision on decreasing the extra reserve of strength (disassembling the part of temporary support) at homogenous part of rock mass around a working. And the compulsory condition for accepting such a decision is inequality:

$$U_{\phi} < U_{cr} \quad (1)$$

where:

U_{ϕ} — actual acceptable displacements of permanent support,
U_{cr} — acceptable displacements of permanent support.

They are measured using the deflexometer designed by the engineers of Donbass State Technical University.

Disassembling of temporary support is implemented in 2–3 stages. After the 1st stage (for example, disassembling of every second frame) the watching is going on for strains of rocks and support state. If absence strains or their decaying nature are revealed as well as the underloadness of frames then the rest of steel frame is disassembled. Periodic control for rock's movements is kept for 6 months.

It's necessary to note that disassembling of underloaded frames at reliable work of permanent support never faces the operational difficulty and idle-time in workings. If watching for state of frame support at any stage of method realization shows its standard state (acceptable final deformations of elements, standard displacements in flexible points, closeness of acting bending moment to their acceptable values), then ascertain, that summarized bearing capacity of permanent and temporary support corresponds to actual load and additional support is left in the working. This case shows the design error of permanent support, which at traditional supporting method would be destroyed that could be resulted in re-supporting and idle-time for repairing the workings.

So, owing to initial creation of reliability reserve for support the high stability of working is guaranteed, which, if error occurs during the design of permanent support, provides its repairless maintenance. Creation of combined structure of super resistivity at the early stages of geomechanical formation allows to decrease deformations and destructions of working contour, size of nonelastic deformation area, and consequently the load onto support. Control for bearing capacity of support by disassembling of temporary structures provides compliance of support with actual geomechanical conditions in the working that guarantees more efficient material consumption of structure along the heading. Meanwhile step-by-step replacement of support with high bearing capacity to designed support practically eliminates risk for working unstability, because decreasing the weight of construction is performed only when underloadness of support is found after the balanced state of massif has been renewed.

Geomechanical application area of new method for keeping the headings of coal mines lies in the II–IV condition categories on rock stability, where bearing capacity plays determining role in providing the stability of working.

One should note wide perspectives of this method in interaction of steel frame structures with permanent roof bolting, especially using of tie bolts. Now industrial application of roof bolting is hold back because of doubts about safety and reliability of its operation in conditions of native mines. The developed method for supporting of mine heading can perform the transfer stage to the wide independent application of tie bolts. Meanwhile the steel frames support can be the so called "assurance" during the most major period of rock contour deformations.

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