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NUMERICAL SIMULATION OF ROCK MASSIF STRESS STATE AT NORMAL FAULT AT UNDERGROUND LONGWALL COAL MINING

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ABSTRACT

Main objective of the executed researches was assessment of the stress and strain state of the rock massif at a normal fault for definition of the rational location of entries of the panel. Numerical simulations were carried out for conditions of flat coal mining by longwall at a normal fault of less than seam displacement. The analysis of the existing normative documents actual scientific researches and issues investigating influence of a fault was made. The possibility of use of numerical simulations for assessment of level of stress at fault is shown and recommendations about arrangement of longwall panel entries are made. The novelty of researches consists in establishment of dependence of the stress and strain state of the rock massif at a fault from the major geological and mining factors.

Key words: underground mining, coal seams, fault, longwall panel, strain-stress state, numerical simulation, strain-stress state

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1. INTRODUCTION

Underground longwall coal mining ensures high efficiency and safety [1-8]. However, existence of faults is capable to have significant effect on overall performance of longwalls. Now mining through fault structures of less than seam displacement is successfully carried

out. However, it is very difficult to mining through faults with of greater than seam displacement therefore faults define a form of mine fields and length of longwall panels. Besides, with increase displacement of a fault the zone of its influence increases. Decrease in strength of rock in a zone of influence of faults leads to change of the field of stress. Besides, upon transition to depth more than 300 m the danger of rock bump increases. During the mining stress field can increase in a zone of influence of a fault that leads to increase in danger of rock bump therefore I exist normative documents which define a coal mining order in dangerous zones at a fault. Questions of safety of underground coal mining remain very relevant for Russia [9-27]. The majority of fields of Russia are rich with faults therefore studying of their influence on the stress and strain state of the rock massif is an important practical task.

2. METHODS

Before carrying out numerical calculation the existing normative documents and works of other researchers devoted to geomechanical justification of mining operations [28-47] and influence of faults [48-50] were studied. When carrying out researches the finite element method was used. The settlement scheme for carrying out researches is submitted in figure 1. Apparently from the drawing 1 numerical modeling of a condition of the rock massif at a fault was carried out at arrangement of longwall panel at distance z from fault at mining of flat coal seam by height **m** at depth **H**.

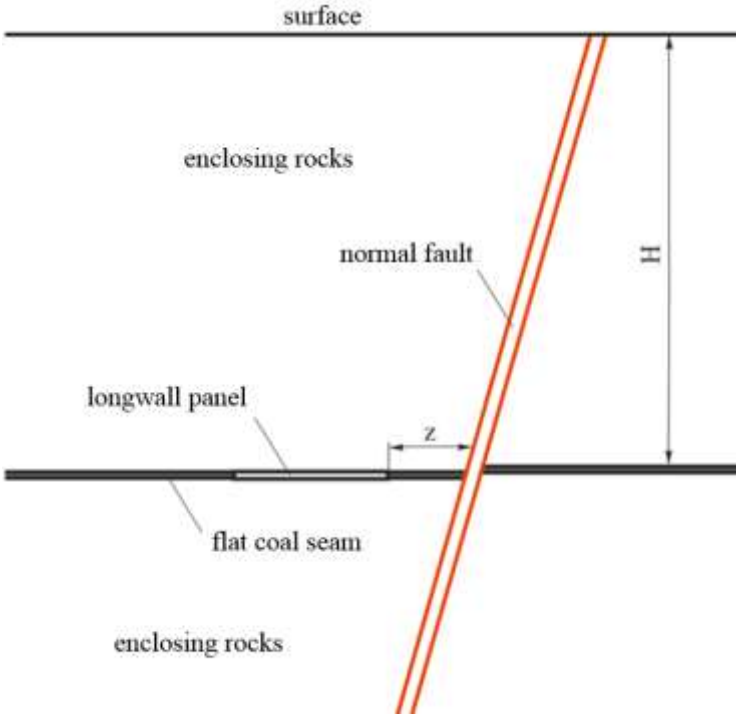


Figure 1. The settlement scheme for numerical simulation

Modeling was carried out with use of the approaches and recommendations stated in Article [50]. Fault was modelled by usual elements with the lowered strength properties.

The research was carried out in 2 steps. At the 1st stage assessment of the sizes of a dangerous zone in compliance with scheme 2 and provisions of the normative document was executed [49]. For the 3 m seam at a depth of 600 m provided that width of a zone of influence of a fault - 25 m, width of a dangerous zone will be about 70 m. Taking into account the sizes of a dangerous zone modeling at value z (figure 1) of equal 75 m was executed. At

the 2nd stage of researches modeling for a mining situation when mining are conducted in a dangerous zone is executed and size z is 25 m.

3. RESULTS AND DISCUSSION

Issues of studying of distribution of stress at a fault devoted considerable number of works [48-50], however their analysis allowed to reveal essential differences in ideas of authors of the nature of the proceeding geomechanical processes. So, typical distribution of the increased stress in a zone of influence of fault is presented in figure 2 [48].

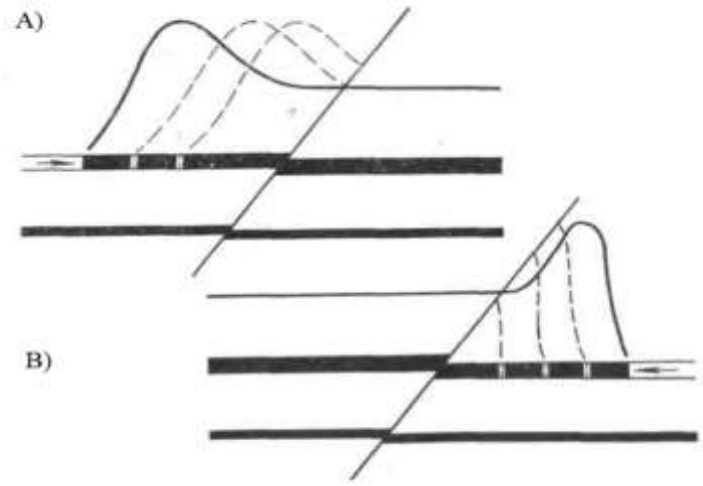
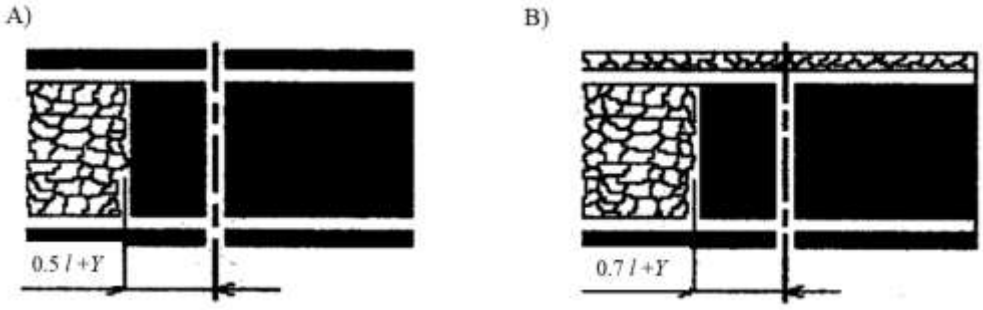


Figure 2. A stress distribution curve at a fault: A) normal fault; C) reverse fault [48]

Figure 2,A shows a stress distribution curve ahead of a longwall by normal fault and confirms constancy of concentration of stress in a zone of bearing stress at change of extent of this zone owing to influence of fault. Too it is observed observed at a reverse fault (figure 2, B). Thus, existence of fault has no significant effect in the field of stress ahead of a longwall, and only leads to restriction of distribution of the increased stress at along strike of seam.

However, according to "The instruction for safe mining in the mines mining the coal seams inclined to rock bump" [49], conditions of conducting mining operations on layers inclined to rock bump in zones of influence of fault carry to particularly complex. Extent of dangerous zones in the presence of faults can be determined by the scheme provided on figure 3.



Y - length of a zone of influence of fault, m; *l* - length of a zone of bearing pressure, m.

Figure 3. The scheme for determination of the sizes of dangerous zones at mining of the seams inclined to rock bump in zones of influence of fault: A) mining of a first longwall panel; B) mining of the second longwall panel [49]

Thus, there is an essential contradiction in work [47] and normative document [49] for the purpose of which permission researches with use of a finite element method were conducted.

As an example of the received results of numerical researches in figure 4 isolines of vertical stress in the neighborhood of longwall panel at fault are shown. Apparently zones of the increased stress - bearing pressure, and directly over and under longwall panel – unloading zones are formed of figure 4 in regional parts of the massif at longwall panel. The zone of fault is characterized by the low level of stress.

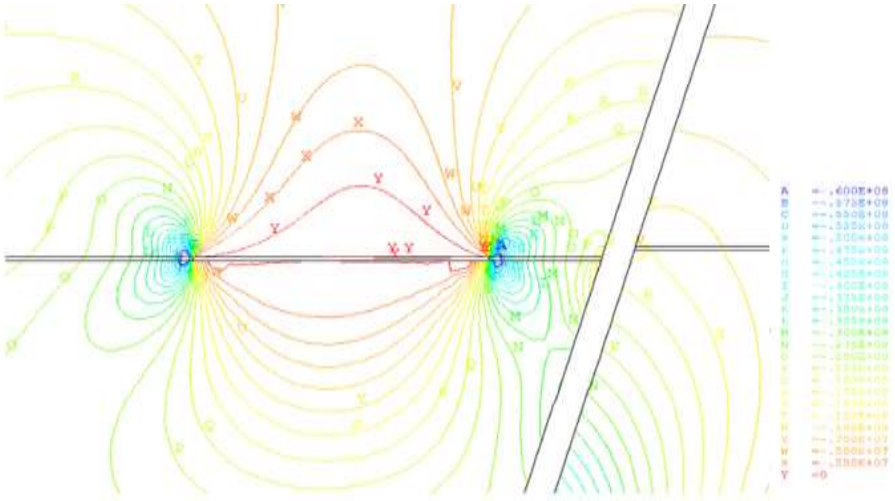


Figure 4. Isolines of vertical stress

For convenience of perception of results the vertical stress curve through contact seam-roof (figure 5) is constructed. Figure 5,A shows that the maximum of stress is in a zone of bearing pressure at distance from a regional part of the massif, as a result of transition of its part to ат extra limit state. The central part of a vertical stress curve within which stress is absent corresponds to a longwall panel 200 m width.

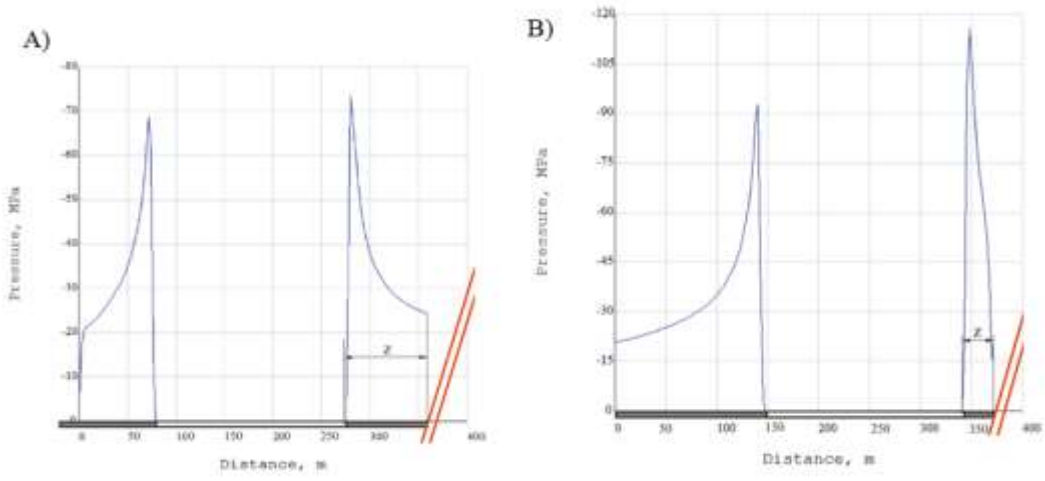


Figure 5. Vertical stress curve: A) at z=75 m; B) z=25 m

As a result of researches it is established that the difference of sizes of the maximum stress from fault from similar from the massif does not exceed 6%. Thus, in the modelled situation (at z=75 m) geological violation has no significant effect on stress of a regional part of the massif.

Apparently from figure 5,B in which vertical stress curve in regional parts of longwall panel at z=25 m are presented the maximum values of stress in a zone of bearing pressure from fault for 25% exceed similar from the massif that demonstrates significant influence of fault on the level of stress.

4. CONCLUSIONS

The location of the longwall panel at fault can lead to decrease in safety and economic efficiency of underground coal mining. However, considerable removal of the longwall panel from fault leads to significant growth of losses of coal. Therefore, the choice of location of the longwall panel at a fault for safety and economic efficiency of production at low losses of coal is very important goal.

Numerical simulation with use of a finite element method showed a possibility of quantitative assessment of stress of the massif at fault. The executed researches confirmed significant influence of fault on stress of the rock massif and need arrangement of entries at distance from fault which depends on displacement of fault, depth of mining, a zone of influence of fault, fault type.

The forecast of stress of the massif is of great importance for ensuring safe deep longwall coal mining.

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