ROCK MECHANICS AND MINE PRESSURE

PREDICTING THE LIMITING ZONES OF INTERSEAM ROCK

S. T. Kuznetsov, N. A. Filatov, and N. F. Donsul

UDC 622.831.32

In the USSR coal industry, zones of elevated mine pressure (IMP) are passed over each year in up to 800 cleaned cuts in coal seams with a dip of up to 35°. The effect of IMP on the transition segments is expressed as an increase in the rate at which side walls draw together, and the change in the character and qualitative parameters of rock failure in the roof: an increase in the rate of fracture, a reduction in the size of the blocks into which the rock is fractured, etc. These factors affect the variation in the stability and loading properties of the roof in conformity with which the bracing should be selected and additional measures developed (when necessary) to prevent the collapse of rock into the cleaned cuts under the bracing. Zones in which interseam rock may go into the limiting state, but not be restricted by the analytical description of its stressed state, should therefore be examined with analytical methods of prediction as applies to cleaned cuts. For the sake of brevity, we will hereinafter say that the purpose of the analytical investigations is to calculate the limiting states in interseam rock for different systems of forces acting on its upper, lower, and lateral boundaries.

Let us examine the question concerning force systems that may form on the upper boundary of an interseam.

As a rule, a formation of coal seams is worked in descending order: the uppermost coal seam is worked at first, and then other seams of the formation sequentially from upper to lower. Beginning with the second seam, all seams of the formation are, in this case, worked beneath the overworked interseam in which it is also necessary to expose the zone of the limiting state.

In predicting zones of limiting state in rock in an overworked interseam, it is extremely critical to assign directly the parameters of the system of forces acting on its upper boundary. These parameters depend on the extent to which the earth's surface is undermined by the upper coal seam, and also on the presence and state of the pillars that remain in working the upper seam.

In sections of the upper interseam boundary, above which the earth's surface is completely undermined, it is possible to assign a uniformly distributed specific load equal to the product of the density of the rock and the depth of embedment of the upper boundary of the interseam for the computations. These sections begin to form under conditions when the minimum dimension of the excavated area $l_{\text{min}}$ of the overworked seam first to exceed the depth $H_{\text{i}}$ of its embedment.

A general diagram of the layout of remaining coal pillars with a width $\alpha$ and excavated space with a width $l$ on the upper boundary of the interseam after working the upper coal seam in a formation lying at a depth $H_{\text{i}}$ is shown in Fig. 1a. In analyzing the diagram, it is necessary to imagine that to the left and right of the pillars, there is a series of pillars between which there are excavated spaces. Different parameters of the force systems in the upper seam, i.e., on the upper boundary of the interseam can be formulated for different combinations of the embedment depth of the upper seam, the width of the pillars, and the strength indicators of the coal.

The coal pillars possess a high residual bearing capacity for certain combinations of pillar width, width of excavated space between pillars, and depth of pillar embedment. The zone of complete rock shear above the excavated space when $l_{\text{min}} < H$ does not propagate to the surface of the earth (Fig. 1b). In all cases, it is necessary to observe the condition of force balance for the calculations. The significance of this condition consists in the fact that the ratio of the sum of the forces transmitted to the interseam through the pillars...
and through the excavated space to the total area of the pillars and excavated space should be equal to $\gamma H_1$. Force systems on the upper boundary of the interseam, which are assigned for computation of limiting zones, should therefore be controlled by this condition.

For a small width of excavated space and its deep embedment, it is sometimes possible to neglect the forces transmitted to the interseam by collapsed rock (Fig. 1c). In each case, the decision to neglect the forces transmitted to the interseam through the excavated space should be based on computations.

The width of the band $l_{\text{nn}}$ on the upper boundary of the interseam (Fig. 1d) on which it is possible to assume uniformly distributed forces with an intensity $\gamma H_1$ is determined from the expression

$$l_{\text{nn}} \approx l_{\text{min}} - H_1 \cot \varphi.$$

It can be concluded from (1) that for small values (usually to 150 m, but rarely more than 200 m), the value of $l_{\text{min}}$ cannot be high, even for a shallow embedment depth of the upper boundary of the interseam.

A segment of the layout of the broad coal pillars that remained between panels (in the diagram, they are situated vertically), and the pillars that remained in the case of the hollow excavations (in the diagram, they are located horizontally) is shown schematically in the upper portion of Fig. 1e. The dimensions of the panel through section A-A and B-B may be large. For the pillarless procedure of working coal, or in the case when narrow pillars, which retain a negligibly small bearing capacity, remain in the hollow excavations it is possible to disregard the forces under them and to assume that a uniformly distributed load $\gamma H_1$ is applied to the interseam over the entire excavated area. In each case, disregard of the forces transmitted onto the interseam via the pillars should be based on computation.

In calculating the limiting states interseam rock, it is therefore possible to assign one of the following four alternate schemes of systems of forces on its upper boundary:

- forces are transmitted only through the remaining coal pillars (Fig. 1c);
- forces are transmitted through the coal pillars and through the excavated space; in this case, the forces on the excavated area do not (Fig. 1b) or do attain (Fig. 1d) $\gamma H_1$; and,