DETERMINATION OF ABUTMENT PRESSURE ZONES
DURING OVERWORKING OF PREPARATORY WORKINGS

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The most promising method for protecting preparatory workings during mining of coals seams at great depths is their location in the footwall of the seams being worked. This method is particularly important in the case of seams prone to shock bumps or rock bursts.

To ensure adequate strength of mine workings without any increase in length of the crosscuts, one must know the minimal safe distance from the seam floor to the stone drift. This article gives a method for determining the zones of harmful effect of abutment pressure having overworking of preparatory workings; it was developed by the Urals Branch of the All-Union Scientific-Research Mine Surveying Institute (VNIMD) from data on the behavior of supports in overworked workings in the Kizel, Chelyabinsk, and Pechora (Inta deposit) coalfields.

To determine the stresses in the temporary abutment pressure zone in the seam floor, we used the results of measurements of deformations at deep reference marks in boreholes drilled in overworked stone drifts. As the boundary of the region of effect of the preparatory working, we took the point with zero deformations, i.e., the sector in which tensile strain passes into compressive strain. These strains are due to the abutment pressure \( \sigma_z \) (the total pressure in the abutment zone \( \sigma_z = \gamma H + \Delta \sigma_z \)), therefore from the known strains one may determine the additional stress from the equations of elasticity theory:

\[
\Delta \sigma_x = \Delta \sigma_y = \lambda \Delta \sigma_z = \frac{\mu}{1 - \mu} \Delta \sigma_z ;
\]

\[
e_z = \frac{1}{E} [\Delta \sigma_z - \mu (\Delta \sigma_x + \Delta \sigma_y)] = \frac{\Delta \sigma_z}{E} \frac{1 - \mu - 2\mu^2}{1 - \mu} .
\]

As the characteristic of the stressed state of the rocks in the abutment pressure zone we take the coefficient of the stress concentration, \( K \), which is the ratio of the stresses arising in the abutment pressure zone to the stresses at any point not affected by mining-out work

\[
K = \frac{\gamma H + \Delta \sigma_z}{\gamma H} .
\]

Substituting Eq. (2) into Eq. (3), we get

\[
K = 1 + \frac{E e_z (1 - \mu)}{\gamma H (1 - \mu - 2\mu^2)},
\]

where \( K \) is the coefficient of stress concentration, \( \gamma \) is the weighted mean-bulk density of the superincumbent rocks in tons/m\(^3\), \( H \) is the depth from the surface in meters, \( E \) is the static modulus of elasticity in kg/cm\(^2\), \( \mu \) is Poisson's ratio, and \( e_z \) is the measured strain of the rock layer.
The values of $\varepsilon_2$ are determined by field observation, $\gamma$, $E_{gt}$, and $\mu$ are determined from rock specimens from borehole cores. For the conditions in the Kizel coalfield $\gamma = 2.5$ tons/m$^3$. The values of $E_{gt}$ were obtained from tests based on the familiar VNIMI procedure [1]. The values of $\mu$ were between 0.15 and 0.35. For practical calculations $\mu = 0.35$ and Eq. (6) may be written as

$$K = 1 + \frac{1.2\varepsilon_2 E_{gt}}{\gamma H}.\quad (5)$$

The results of measurements in three boreholes, drilled from the stone drifts being overworked, were processed by Eq. (5). In processing these measurements the coefficient of stress concentration was determined only for sectors of the working mass free from the effect of the preparatory working from which the borehole was drilled.

Figure 1a shows the stress distribution pattern in the floors of the seams being worked in the zone of effect of temporary abutment pressure, expressed in contours of the stress concentration coefficients. It will be seen that in all three cases the configuration of the temporary abutment pressure zone in the floors of the seams being worked is the same and corresponds to the picture developed as a result of investigations in [2-4]. The maximal dimensions of the abutment pressure zone in the seam floor along the normal are equal to those of the abutment pressure zone in the plane of the seam under these conditions. The maximal stress concentration is observed 3-5 m into the rock from the front of the mining operations.

The maximal coefficient of stress concentration depends on the depth of the working [5] and the seam dip. Figure 1b shows the actual value of $K_{\text{max}}$ at different seam dips and different depths. Assuming that the stress varies with the dip as the normal component of the weight of the rock $(K \cos \alpha)$, the effect of $H$ on $K_{\text{max}}$ is determined from practical data. This equation may be expressed empirically by the formula

$$K_{\text{max}} = 5 \cos \alpha - 0.0013H,\quad (6)$$

where $H$ is the depth of the position in meters and $\alpha$ is the seam dip, in degrees.

Figure 1c is a plot of $K_{\text{max}}$ in the abutment pressure zone in the seam floor vs only the seam dip along a line drawn normally to the seam through the point of maximal stress at a distance of 3-5 m from the edge of the working face. The ratio $l_n/L$, where $l_n$ is the distance along the normal from the seam floor and $L$ is the length of the abutment pressure zone, is plotted on the horizontal axis.

*The measurements were made in the Kizel Territorial Laboratory of Shock Bumps of VNIMI by B. Sh. Vinokur and G. S. Nazarov.