REDISTRIBUTION OF ABUTMENT PRESSURE
ON STOWAGE MATERIAL WHEN
THICK STEEP SEAMS ARE WORKED BY THE
SLICING SYSTEM

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Mining of thick coal seams, particularly if steep, involves considerable difficulties, largely owing to imperfect rock pressure control. Methods which enable one to control effectively the immediate and main roofs if the seam is thin or of medium thickness give poor results in the case of thick steep seams. For example, the supports used in the extraction of thick steep seams can act only as temporary supports or protect the working area in the mining-out face. Such supports have virtually no effect on the behavior of the main roof.

Somewhat improved main roof control in thick steep seams is attained by leaving coal pillars or by complete stowing of the worked-out area. However, the use of coal pillars increases the losses of coal and heightens the probability of accidents in the mine workings and of endogenous fires. Complete stowing of the worked-out area has an appreciable effect on the behavior of the main roof only when the stowing material has fairly high compressibility.

The bearing capacity of the stowing material and the intensity of its reaction with the roof rocks increase with the compressibility. We then have the possibility of marked deconcentration of the abutment pressure by redistribution on the stowing material.

Experience of the working of thick steep seams with stowing in the Prokop'evsk-Kiselevsk region of the Kuzbass shows that hydraulically stowed material consisting of crushed sandstones, siltstones, and argillites exhibit marked shrinkage. For example, in the system of working inclined slices with hydraulic stowing, subsidence of the roof rocks is 35-38% of the thickness of the slice being extracted. In this case, shrinkage of the stowing material along the normal to the seam is as high as 32%, but is less than 1.0% to the dip [1, 2].

Stowing material with such poor compressibility does not have the necessary bearing capacity when the next batch of stowing material is introduced. As a consequence, the abutment pressure is concentrated over the extremities of the seam, and displacement of the roof in these pressure zones reaches 4-5% of the thickness of the inclined slice during its extraction. Furthermore, when the mining-out face advances to the next stowing interval, displacement of the roof increases by a further 6-7%. By the time the stowing material arrives, the roof may have sunk by 10-12% of the thickness of the inclined slice.

Marked shrinkage of the stowing material is one of the principal factors greatly influencing the parameters of working by the slicing system. When slicing systems with stowing were first used, thick seams were divided into inclined slices of virtually equal thickness and each slice was worked by long pillars to the strike (the level being divided into two or three sublevels); later, however, inclined slices were extracted by horizontal strips, 8-15 m wide. At a working depth of more than 250 m, the width of the horizontal strips is frequently reduced to 6 m or even 4.5 m.

To increase the density of the stowing material during shaping, with very few exceptions, extraction of coal seams and inclined slices is performed from the haulage horizon to the ventilation horizon. With increasing depth of mine workings, preference in the selection of the working system is being accorded with increasing frequency to transversely inclined slices; during operations in the third and fourth levels, the thickness of the seams and inclined slices to be worked by this popular method is usually not more than 6.5 m. In thicker seams, the most usual procedure
Fig. 1. Isolines of equal compaction of stowing material.

adopted is preliminary underworking by extraction with stowing of an inclined slice at the floor of the seam. If the seam thickness is more than 10.5 m, the underworked inclined slice is mined by transversely inclined slices.

Recently mechanized methods for extracting horizontal strips have been developed and introduced; in certain cases, units and powered supports with special stowing compacting devices will be used. With mechanized extraction, the width of the strips is often reduced to 3-3.5 m.

With decreasing strip width, the stowing material approaches the extremities of the seam and actively reacts with the roof rocks sooner than in the case of thicker strips. It is then possible to increase considerably the shrinkage of each layer of stowing material to the dip of the seam. The feasibility of such layerwise compaction is confirmed by information obtained by the use of the transversely inclined slice system; shrinkage of the stowing material to the dip of the seam reaches 10-13% of the slice thickness, 8-10% of the shrinkage occurring during the working of one or two transversely inclined slices [1]. As a consequence, shrinkage of the stowing material normal to the stratification is practically halved.

Thus when slicing systems are used, when the stowing material consisting of crushed sedimentary rocks is shaped to the rise of the seam in narrow horizontal strips or in layers, and is not more than 4.5 m away from the extremities of the seam, displacement of the roof rocks and the abutment pressure concentration are both greatly reduced.

The abutment pressure is deconcentrated to a greater extent during extraction of a preworked inclined slice, if the underlying inclined slice is worked with stowing and the stowing material in the worked-out area of the slice has not yet been compacted to such a degree that it has completely lost its pliancy. The underlying layer of stowing material is then a pliant support, which helps to redistribute the abutment pressure over a greater supporting area.

The degree of compaction of the stowing material in the worked-out area of an inclined slice may be calculated by means of the equation

$$ \eta = \frac{U}{k_H m_c} \times 100\%,$$

where $U$ is the displacement of the roof rocks above the stowing material normal to the stratification, in millimeters, $k_H$ is the coefficient of maximal shrinkage of the stowing material normal to the seam, and $m_c$ is the thickness of the inclined slice, in millimeters.

The coefficient $k_H$ characterizes the maximum possible compaction of the stowing material displaced by the wallrocks. Its value is determined from the ratio of the maximum shrinkage of the stowing material normal to the seam to the thickness of the inclined slice. Under the conditions obtaining in the Prokop'evsk-Kiselevsk coalfield, when thick steep seams are worked by inclined slices with hydraulic stowing of the worked-out area by crushed rocks from local quarries, $k_H = 0.28-0.32$.

Figure 1 shows contours of equal compaction of the stowing material in a worked-out inclined slice, constructed from the results of measurements of roof rock displacement. The degree of compaction of the stowing material on completion of extraction of the inclined slice was calculated for $k_H = 0.30$.

Changes in the stowing material density were investigated experimentally during trials of a new slicing system, characterized by the use of long mechanized faces in the inclined layers, the faces advancing along the strike