ROCK PRESSURE IN SHIELD-WORKING OF A STEEP SEAM IN THE SULYUKTA DEPOSIT

G. P. Kalinin

The shield winning system has been tried in thick steep seams in collieries in the Sulyukta, Tashkumyr and Dzhergalan deposits of Central Asia.

To determine more accurately the coefficients of the shield system (pillar dimensions along the strike and the dip, design of the shields, disposition of coal-chute staple pits, development sequence of extraction pillars and shield control methods), particularly for conditions in the Sulyukta deposits (where rock pressure is high), the Institute of Rock Physics and Mechanics of the Academy of Sciences of the Kirgizian SSR carried out underground research at colliery 6, on rock movement and the laws governing rock pressure manifestations.

The shields were used in coal winning zone No. 1. The second level was worked. The depth at which working was carried out, from the ventilating level to the surface, was 170-180 m, and the average thickness of seam F in the zone was 5.5 m. The dip was 86-87°. Seam F has a complex structure. A dull brittle coal (thickness 2.5-3.3 m) occurs at the roof, followed by bands of clay shale (10-15 cm); at the foot of the seam there is a pack of weak coal, a vitrinite 2-2.5 m. The immediate roof in seam F is composed of clay shale (6 m), while the main roof consists of weak conglomerates; the floor of the seam is clay shale, clays and conglomerate.

Field tests of the physical and mechanical properties of the surrounding rock in seam F were carried out with an impression device devised by the VNIMI (All-Union Scientific Research Mine Surveying Institute); they showed that rocks such as clays, clay shales, conglomerates and breccia undergo mainly plastic deformation as a result of rock pressure. The table gives the properties of the coal and rock in the immediate roof and floor of seam F in the Sulyukta deposit, as found in the laboratory. It will be seen that all the surrounding rocks have low strengths.

At the higher level, and also in the neighboring zone in the direction of the strike, the seam is worked out in short pillars and rooms. All the staple pits were supported with timber-frame set supports consisting of props 15-20 cm in diameter.

Visual inspection paid special attention to the conditions and dimensions of the inter-shield and abutment pillars, the coal packs at the floor and the roof of the seam, shields and support features in development workings (as the shield descended). A system of paired datum points was used to determine convergence in the surrounding rock. The datum points were arranged in the ventilation road, the intermediate conveyor road, the crosscuts, and the thirlings. Convergence of the datum points was measured to within 0.1 mm once every 24 h, using a tape measure designed by the All-Union Scientific Research Mine Surveying Institute, and universal props of the SU-11 type. These observations were made when working the first, fourth and eighth shield pillars.


Fig. 1. General view of preparation of shield pillar and location of twin datum points: 1) haulage road; 2) lower conveyor road; 3) upper conveyor road; 4, 6) thirlings; 5) intermediate road; 7) airway; 8) crosscut; 9) ventilation road.
Much more detailed observations were carried out in working the fourth shield pillar. A shield 24 m in length, over a seam thickness of 4.5 m, was assembled from two rows of rolled sections with additional central girder flanges.

Figure 1 shows the arrangement of the datum points in the shield pillar 4.

During operations, the supports in all the coal chute pits (especially those rather nearer the waste) were markedly deformed and the staple pits underwent complete disintegration; supports at the openings of all the staple pits underwent 1.5-2.5 m deformation as the shield moved. The supports were completely broken before the shield had even reached the intermediate road or the belt road. The most marked deformation of the supports occurred in a zone 2-13 m ahead of the shield face, and 3-10 m behind it. After the manway had been supported, deformation of the new supports decreased and then occurred at a distance of 5-8 m behind the shield face.

The shield control method provided for the shield to move in the plane of strike of the seam and did not allow for the necessary coal pillars; this increased the rock pressure.

Figures 2-4 give measurements of movements of the surrounding rock during the time the shields were in operation. Convergence of the datum points placed at the crosscuts on the unworked coal side amounted to 100-180 mm over the period from the beginning of shield pillar working until the shield had passed. As the shield approached the intermediate road, datum points converged by 150-248 mm. Maximum overall convergence values for the rock side-walls over the period of observations were obtained in the ventilation road--datum point 1, 299.8 mm; in the intermediate road--datum point 2, 248.5 mm and point 1, 224.8 mm; in the belt road--datum point 1, 264.1 mm; and in the crosscuts--datum point 1, 231.2 mm.

For comparison, it should be noted that in the Kuzbass collieries datum point convergence in crosscuts on the unworked-coal side at the moment the shield passed was 40-80 mm, being 90-120 mm over the entire period of pillar recovery [1]. This is due to the fact that the surrounding rock of seam F is weak clay strata and conglomerates, which tend to undergo plastic deformation under comparatively small loads.

Maximum average daily rates of convergence in the datum points were found in the intermediate road--datum point 2, 8.24 mm/day, point 1, 6.7 mm/day; in the conveyor belt road--datum point 1, 7.34 mm/day; in crosscuts--datum point 2, 9.2 mm/day, and datum point 1, 6.08 mm/day; in the ventilation road, the rate of convergence at datum point 1 was 4.16 mm/day. When seam F was mined by the shield system, convergence rates at the datum points were very much higher than those observed in Kuzbass collieries.

Figure 3 shows convergence of the datum points, and the daily average rates of convergence in the surrounding strata, versus the distance between the shield and the datum points.

The rate of compression of the seam increases when the shield has reached 12-15 m from the datum points. Thus the datum point convergence rates in crosscuts 1 and 2 were 2-4 mm/day, while