NEED TO DESIGN YIELDING PROPS FOR KTU EQUIPMENT

F. P. Bublik and Yu. V. Gromov

UDC 622.28

Thick level coal seams at Tom'Usinsk in the Kuzbass and certain other deposits are mined by a combined system involving KTU equipment and taking out a 7-12 m seam in two stages. The top slice of approximately 2 m is broken out first in longwalls with roof caving, and a flexible covering is erected on the floor of this layer. The bottom part of the seam is mined out under the caved rock from the undercut slice at the floor of the seam using KTU waste-edge sectional supports [1].

Practice with this type of support has shown that the props and connections of these with the roof bars and bed tend to become distorted and go out of service. The reason why the support fails is that the props are rigid in design and have no means of yielding when load increases.

The advisability of designing some degree of yield into KTU supports was studied by means of models and by assembling data on their deformation characteristics in faces at the Tomusin 1-2 and Tomusin 5-6 collieries in the Kuzbass.

These tests were carried out on three-dimensional models, maintaining geometrical similarity and keeping the internal friction angles of the caved rock (35-40°) and those of the material used in the model (32-45°) equal. Models were made on a 1 : 200 scale on a stand 1200 x 900 x 500 mm from free-flowing material (sand, gravel), and from single blocks of regular shape made from equivalent materials. Tests on models from various materials showed a qualitatively identical picture of load change on the support, while the absolute load values on the models made from bulk materials were about 15-20% higher than those made in block form. The inter-slice pack of coal and the coal mass surrounding the face on three sides were represented in the model by the "boundary limit system" [2].

In the tests, we simulated a support of the breaking-off edge, rising characteristic type. A model of the support was made as before in the form of spring steel brackets varying in gauge. Wire tensometers were glued to the brackets and graduated in terms of load and deformation. The measurements were effected by the bridge method with a mirror galvanometer of the M-95 type. The transducers (brackets) were in four grades of stiffness (Table 1).

The specific yield of the support $1/\lambda$ is the reciprocal of the rigidity $\lambda$. The rigidity of the KTU2 support in the elastic deformation stage of the prop is about 150 tons/m $\cdot$ mm. However, in the mine, the coal and rock fines are crushed where the support is in contact with the surrounding strata (20-30 mm). The rigidity of the support will be between limits of 5.0-7.5 tons/m $\cdot$ mm. The characteristics of an actual support are simulated most closely by second-type transducers with $\lambda = 6.0$ tons/m $\cdot$ mm (specific yield $1/\lambda \approx 0.17$ mm $\cdot$ tons/m).

The tests on the models were based on the fact that the KTU support is involved in several loading routines during one mining cycle in the bottom slice, the most characteristic from the point of view of load forming being these two: one routine (I) corresponds to the period over which the support is reacting with the broken roof and is characterized by comparatively low movement (0.3-0.5 m) of the roof and the under-worked coal mass; the other routine (II) is the period where the support reacts secondarily with the repeatedly caved rock which follows the breakdown of the roof, and the movement of this rock takes place to a considerable height (5-7 m). The models were studied to take account of these prop working conditions (Fig. 1). The face length on the model was 11 and 23 cm, spill height 23 and 46 cm. Two hundred models in all were tested.

The results of the tests on the models using sand with a face length of 23 cm (46 m in the mine) are given in Fig. 2. The specific yield values used in the models are plotted on the abscissa and the load values on the props...
TABLE 1

<table>
<thead>
<tr>
<th>Rigidity of support $\lambda$</th>
<th>Type of transducer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>In model, g/cm $\cdot$ mm</td>
<td>1562</td>
</tr>
<tr>
<td>Converted to field condi-</td>
<td></td>
</tr>
<tr>
<td>tions, tons/m $\cdot$ mm</td>
<td>48.0</td>
</tr>
</tbody>
</table>

Fig. 1. Diagrams of working conditions of KTU supports in the mine (a) and in models (b).

obtained in tests on identical models using 2 systems (see Fig. 1) on the ordinate. We should note here that in this particular case the load was numerically equal to the reaction of the support. Figure 2 shows that in a support with a higher degree of yield, all other things being equal, the load is less.

The data from these tests carried out on models for the two routines of prop working as above in natural conditions, showed the qualitatively identical character of the relationship between them. However, absolute load values on the support in the tests on the I system (Fig. 2, curve I) are slightly larger (10-50%) than in tests using II (Fig. 2, curve II); furthermore, as the yield increases this difference decreases. Maximum loads on the prop with this particular characteristic occurs when it is reacting with the broken roof; this is confirmed in practice.

An increase in the yield in the model supports (see Fig. 2) from $5.1 \cdot 10^{-3}$ to $25.6 \cdot 10^{-3}$ mm $\cdot$ g/cm (in the field from 0.17 to 0.84 mm $\cdot$ tons/m), i.e., roughly by five times, reduces the load by a mere 20-30%. Specific yield of actual supports in the field lies close to the 0.17 mm $\cdot$ tons/m value (Fig. 2, hatched) and therefore we may say that the actual support works in an area where the load on the support is determined very slightly by the prop characteristics. For a load reduction of 20-30%, a yield of about 100 mm must be designed into the props.

Thus in the conditions examined here, the mechanical characteristics of the support will evidently have a more marked effect on the load value. Therefore, any yield designed into the supports will not produce a marked load reduction.