ГИАБ. Горный информационно-аналитический бюллетень /
MIAB. Mining Informational and Analytical Bulletin, 2023;(4):157-167
ОРИГИНАЛЬНАЯ СТАТЬЯ / ORIGINAL PAPER

УДК 622.23.05 DOI: 10.25018/0236_1493_2023_4_0_157

ОБЕСПЕЧЕНИЕ ПОПЕРЕЧНОЙ УСТОЙЧИВОСТИ ЩИТОВОЙ СЕКЦИИ МЕХАНИЗИРОВАННОЙ КРЕПИ ПРИ ВЫЕМКЕ ПОЛОГИХ И НАКЛОННЫХ УГОЛЬНЫХ ПЛАСТОВ

Ю.В. Турук[1], Н.И. Сысоев[2], Б.Б. Луганцев[2], С.В. Стрельцов[1], А.А. Богомазов[1]

[1] Шахтинский автодорожный институт (филиал)
Южно-Российского государственного политехнического университета (НПИ)
имени М.И. Платова, Шахты, Россия, e-mail: uraturuk@mail.ru
[2] Южно-Российский государственный политехнический университет (НПИ)
имени М.И. Платова, Новочеркасск, Россия

Аннотация: Приведены результаты исследований поперечной устойчивости однорядных и двухрядных щитовых секций механизированных крепей и их стабилизирующих устройств при выемке тонких и средней мощности пологих и наклонных угольных пластов. При этом в качестве стабилизирующего устройства рассматривались широко применяемые пружины сжатия, установленные на толкателях выдвижных бортов перекрытия и заднего ограждения. Установлено, что эффективное применение пружин сжатия возможно только при выемке тонких и средней мощности пологих угольных пластов. При выемке наклонных угольных пластов, особенно средней мощности, эффективность применения пружин сжатия в качестве стабилизирующих устройств резко падает. Обосновано использование в качестве стабилизирующего устройства гидродомкратов выдвижных бортов перекрытия и заднего ограждения с установленными на их поршневых полостях гидроблоками, в которые встроены предохранительный и разгрузочный клапаны. Установлена зависимость настройки предохранительного клапана гидродомкрата от горизонтальной составляющей усилия распора гидростоек секции крепи. При распоре секции крепи усилие на гидродомкратах выдвижных бортов должно быть не ниже удерживающего секцию усилия. Разработана методика определения давления срабатывания предохранительного клапана гидродомкратов, т. е. заданной нагрузки выдвижных бортов, обеспечивающих поперечную устойчивость однорядной и двухрядной щитовой секции механизированной крепи.

Ключевые слова: поперечная устойчивость, щитовая секция, механизированная крепь, стабилизирующее устройство, гидродомкрат, предохранительный клапан, выдвижной борт, гидростойка.

Для цитирования: *Турук Ю. В., Сысоев Н. И., Луганцев Б. Б., Стрельцов С. В., Богомазов А. А.* Обеспечение поперечной устойчивости щитовой секции механизированной крепи при выемке пологих и наклонных угольных пластов // Горный информационно-аналитический бюллетень. – 2023. – № 4. – С. 157–167. DOI: 10.25018/0236_1493_2023_4_0_157.

Ensuring the transverse stability of the shield powered support unit when excavating shallow and inclined coal seams

Yu.V. Turuk[1], N.I. Sysoev[2], B.B. Lugantsev[2], S.V. Streltsov[1], A.A. Bogomazov[1]

[1] Shakhty Road Institute, Branch of Platov South-Russian State Polytechnic University (NPI), Shakhty, Russia, e-mail: uraturuk@mail.ru

[2] Platov South-Russian State Polytechnic University (NPI), Novocherkassk, Russia

Abstract: The results of studies of the transverse stability of single-row and double-row shield powered support units and their stabilizing devices, when excavating bed seams and middle shallow and inclined coal seams, are presented. At the same time, widely used compression springs installed on pushers of the sliding sides of the overlap and rear guard were considered as a stabilizing device. It is established that the effective use of compression springs is possible only when excavating bed and middle shallow coal seams. When excavating inclined coal seams, especially of middle seam, the efficiency of using compression springs as stabilizing devices drops sharply. The use of the sliding sides of the overlap and the rear guard with hydraulic blocks installed on their piston cavities, in which safety and discharge valves are integrated is justified as a stabilizing device for hydraulic jacks. The dependence of the setting of the hydraulic jack safety valve on the horizontal component of the force of the hydraulic struts of the support unit is established. At the same time, when the support unit is spaced, the force on the hydraulic jacks of the retractable sides should not be lower than the force holding the unit. A method has been developed for determining the actuation pressure of the safety valve of hydraulic jacks, i.e. the specified load of the sliding sides providing transverse stability of the single-row and double-row shield powered support unit.

Key words: transverse stability, shield unit, powered support unit, stabilizing device, hydraulic jack, safety valve, retractable side, hydraulic resistance.

For citation: Turuk Yu. V., Sysoev N. I., Lugantsev B. B., Streltsov S. V., Bogomazov A. A. Ensuring the transverse stability of the shield powered support unit when excavating shallow and inclined coal seams. *MIAB. Mining Inf. Anal. Bull.* 2023;(4):157-167. [In Russ]. DOI: 10.25018/0236_1493_2023_4_0_157.

Introduction

One of the criteria for the technical perfection of powered support units is the coefficient of self-stability of the unit.

Unit stability is the ability of a unit to maintain such a spatial position under the influence of external force factors, in which its normal operation in a mechanized support system is possible.

The main type of stability is transverse or lateral stability. When the transverse stability is lost, the unit overturns, i.e. the unit rotates around the edge of the base or axis located at some distance from the edge, depending on the physical and mechanical properties of the soil [1, 2].

The critical angle at which it is possible to overturn the support unit without a stability system can be determined from the condition of equality of the overturning and equalizing moments relative to the edge line of the base from the side of the seam gradient. With an increase in the angle of occurrence of the seam, a progressive loss of stability of the unit is observed both in the system of internal stability of the units and in the system of their external connections, leading to an increase in the complexity of their operation and maintenance.

The ratio between the number of shallow seams with angles of incidence up to 18° and inclined from 19° to 35° is 78.4% and 21.6%, respectively.

In addition, the stability of the support unit is significantly affected by the removed seam height. According to the seam height, the seams are divided into four groups: very thin bed seams to 0.7 m; bed seams — from 0.71 to 1.2 m; middle seams — from 1.21 to 3.5 m and high seams — over 3.5 m.

An increase of seam height leads to changes in the center of gravity of the unit relative to the base and, accordingly, the stability of the support unit.

The loss of stability of the support unit and the resulting deterioration of the interaction of the unit with the lateral rocks of the seam contributes to the destruction of the roof over the unit.

As the operation of the complexes has shown, when excavating inclined seams, powered support units should be equipped with special stability systems.

The purpose of the research is to determine the power parameters of the transverse stability system of the shield powered support unit and the development of a stabilizing device.

To achieve this goal, it is necessary to solve the following main tasks:

- analyze the results of the operation of powered support units when excavating seam with angles of incidence up to 30° in order to determine the causes of loss of stability of units;
- perform an analysis of studies aimed at ensuring the stability of powered support units;
- to establish a rational structure and power parameters of the stabilizing device of the transverse stability of the shield powered support unit for shallow and inclined seams.

Research methods: analysis and generalization of information contained in literary sources, analytical studies of transverse stability by methods of theoretical mechanics.

Results

Currently, single-row and double-row shield sections with solid rigid bases and with bases divided into elements (skids), connected along the blockage by clamps, and along the bottom screed, are widely used. In accordance with GOST 33164.1-2014, the blockage fence and the overlap of the support unit on both sides are equipped with retractable sides to block intersectional gaps from spilling into the face space of the bayonet lying on the overlap and the blockage fence (Fig. 1) [3—5]. The retractable sides *1* are equipped with pushers *2*, with compression springs *3* mounted on them, which perform the functions of a stabilizing device when moving the support unit.

The operation of powered support units has shown the effectiveness of compression springs only when excavating bed seams

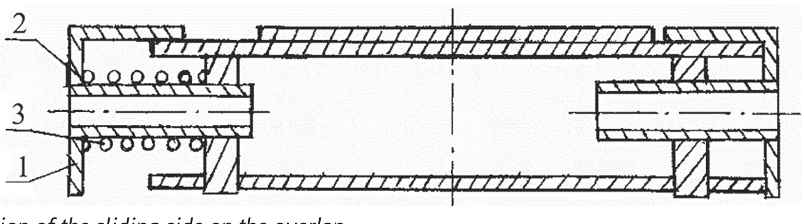

Fig. 1. Section of the sliding side on the overlap
Рис. 1. Сечение выдвижного борта на перекрытии

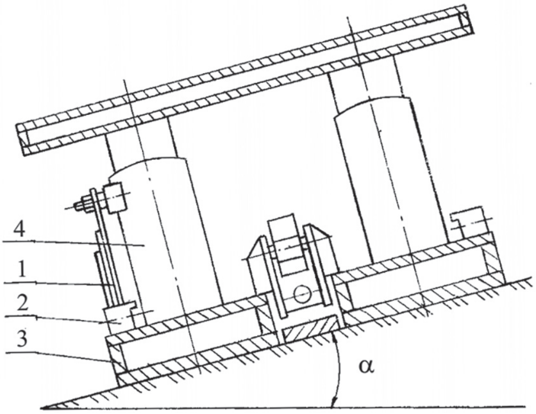

Fig. 2. Element of the system of the stabilizing device of the KD90 support section
Рис. 2. Элемент системы стабилизирующего устройства секции крепи КД90

shallow coal to 18°. When excavating inclined (from 18° to 30°) seams, the efficiency of using compression springs as a stabilizing device drops sharply due to their operating characteristics, i.e., the dependence of the spring force on the magnitude of its compression (working stroke) [6—9].

To correct the position of the support section that has lost stability after moving, before the strut in the overlap or under it and the blockage fence, hydraulic jacks of the retractable sides are installed, which forcibly carry out their sliding and folding [10—14].

To increase the transverse stability of the units when excavating not only flat, but also inclined (α = 18—30°) coal seams, double-row shield powered support units with a solid rigid base (CD90, CD90T) are additionally equipped with a package of springs *1* installed in the pocket *2* of the base *3* and resting on the cylinder *4* of the front lower hydraulic support (Fig. 2). In addition, a solid rigid base made it possible to install paired (welded together) rigid front levers of the four-link rear guard [15—19].

However, when excavating shallow middle coal seams, the springs were broken and, as a result, the transverse stability of the support unit was lost. The consequence of the fracture of the springs was their insufficient rigidity (the ratio of the load to the corresponding deflection), especially when the units are spaced. With a sufficiently low stiffness, the spring cannot have the necessary strength to ensure its operation under variable loads.

The installation of paired rigid front levers of the four-link rear guard ensures the transverse stability of the blockage of the support section within the design tolerances.

It should be noted that their installation in the skids of a divided base is not possible due to the peculiarities of the kinematics of the interaction of skids with the soil of the formation when the unit is operating in difficult mining and geological conditions (soft floor or the presence of «thresholds» in the soil of the formation).

When determining stability, the rotation of the maximally extended support unit during its movement occurs around the lower edge of the solid rigid base or around the edge of the lower element (skid) of the divided base.

Fig. 3 shows the design scheme of the transverse stability of a single-row shield support unit.

Tipping moment relative to point *A*:

$$M_o = G_h \cdot h = h \cdot G \cdot \sin\alpha \text{, kN,}$$

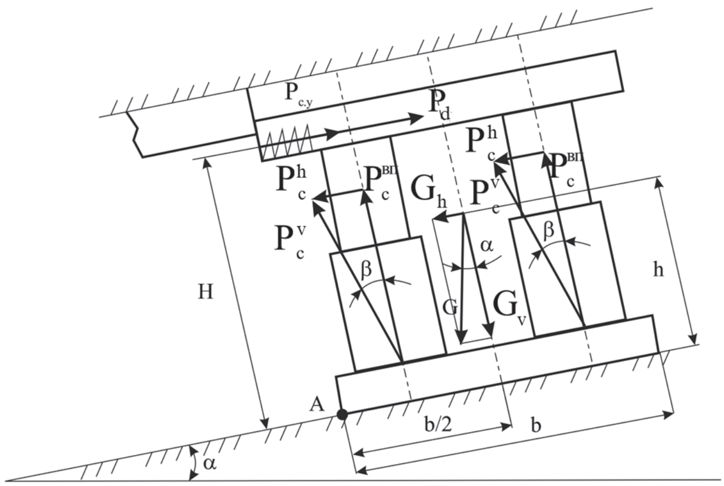

Fig. 3. Design diagram of the transverse stability of a single-row shield support unit
Рис. 3. Расчетная схема поперечной устойчивости однорядной щитовой секции крепи

where G is the weight of the support unit, kN; G_h — the horizontal component of the weight of the support unit, kN; α — the seam gradient, deg.; h — the shoulder of the horizontal component of the unit weight, m.

Restoring moment relative to point A:

$$M_v = G_v \cdot \frac{b}{2} = \frac{b}{2} \cdot G \cdot \cos\alpha \text{, kN,}$$

where G_v — the vertical component of the weight of the support unit, kN; b — the width of the base, m.

Stability condition:

$$M_o \lhd= M_v \,.$$

Stability margin of the support unit:

$$n_{y.c.} = \frac{M_v}{M_o} \rhd 1 \,.$$

It is known that when the tipping moment exceeds the restoring moment ($M_o \rhd M_v$), the transverse stability of the support section must be provided by stabilizing devices.

Since in the shield powered support units, the sliding sides of the overlap and the rear fence of the higher units are supported by the sides of the lower unit, the stabilizing devices of the sliding sides must compensate for the missing restoring moment.

Compensating moment of the stabilizing device:

$$M_k = M_o - M_v = P_{c.y.} \cdot H \text{, kN·m,}$$

$$P_{c.y.} = \frac{M_k}{H} \cdot n_y \text{, kN,}$$

$$P_{пр.} \rhd P_{c.y.} \,,$$

where $P_{c.y.}$ — the force of the stabilizing device, kN; H — the arm of stability of the force application of the stabilizing device, m; n_y — stability margin; $P_{пр}$ — the force of deformation (compression) of the spring, kN.

It follows from the moment equations that the restoring moment depends on the seam gradient, the power and structural parameters of the support unit (unit weight and base width), and the tipping moment depends not only on the seam gradient, but also on arm of stability of the horizontal component of the unit weight, i.e. the seam height.

The force of the stabilizing device $P_{c.y}$ (the deformation force of the springs $P_{пр}$) of a specific design of the support unit is determined at its maximum extensibility and the maximum angle of incidence of the inclined formation of 30°. At the same time, the minimum deformation force of the spring should be within $0.1 \cdot P_{max} \leqslant P_{min} \leqslant 0.5 \cdot P_{max}$ and increases to the value of P_{max} when it is compressed within the working stroke equal to the value of the extension of the side shields.

Based on the design features and operating conditions of the compression spring, i.e. its operating characteristics, it is not advisable to use compression springs as a stabilizing device.

A significant influence on the transverse stability of the support unit is exerted by the angle of inclination of the struts along the seam gradient. The minimum angle of inclination of the racks creates the smallest horizontal component of the strut force of the racks and thereby contributes to increasing the transverse stability of the support unit when it is spaced (Fig. 3).

Therefore, as a limiter of the angle of inclination of the struts along the seam gradient and, accordingly, the displacement of the overlap, it is advisable to use the hydraulic jacks of the retractable sides. To do this, it is necessary to equip the hydraulic jacks with hydraulic blocks, in which the safety and discharge valves are integrated. Fig. 4 shows the hydraulic circuit of the hydraulic jack *1* of the retractable side and the hydraulic unit *2*, with built-in safety *3* and discharge *4* valves.

The safety valve is designed to protect the hydraulic jack from overloads and provide a set pressure in the piston cavity of the hydraulic jack, i.e. a set load that ensures the transverse stability of the support unit both during its movement and during the spacer. The safety valve is triggered when the horizontal component of the strut force P_c^h is exceeded [20–22]. At the same time, there is no need to adjust the position of the support unit before its expansion after moving.

Determination of the actuation pressure of the safety valve of the hydraulic unit of the hydraulic jack of the retractable side.

The requirements for directional movement of the support unit are presented [2]: support of the movable unit on the lower prostrate; retractable sides to overlap the intersectional gaps of active action; provision of directional movement when the unit deviates by 2° from the normal to the plane of the formation.

In this case, the force holding the movable support unit must be higher than the force required adjusting the position of the unit.

When the support unit is spaced after its movement, the holding force should be higher than the horizontal component of the P_c^h of the racks, i.e. the force on the hydraulic jacks of the sliding sides should not be lower than the holding force of the support unit.

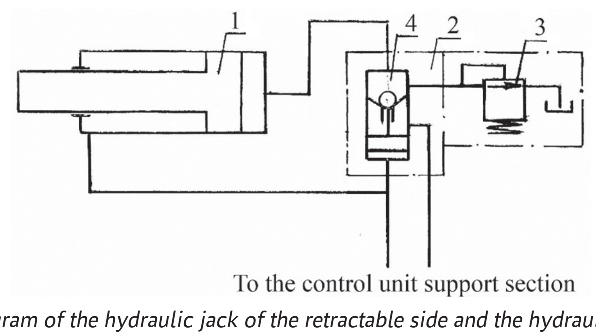

Fig. 4. Hydraulic diagram of the hydraulic jack of the retractable side and the hydraulic unit
Рис. 4. Схема гидравлическая гидродомкрата выдвижного борта и гидроблока

The actuation pressure of the safety valve of the hydraulic unit of the hydraulic jack of the retractable side of the single-row shield powered support unit.

The structure of the single-row shield powered support unit includes two racks and two hydraulic jacks of the sliding sides of the overlap and the rear fence.

The actuation pressure of the hydraulic jack safety valve, i.e. the maximum force is determined from the strut of one rack:

$$P_{kl} = \frac{4 \cdot P_d}{\pi \cdot D_{n.d.}^2 \cdot 10^3}, \text{ MPa},$$

where $D_{n.d}$ – is the diameter of the hydraulic jack piston, m; P_d – hydraulic jack force, kN:

$$P_d = P_c^h = P_c^v \cdot \sin\beta = P_c \cdot \cos\gamma \cdot \sin\beta, \text{ kN},$$

where P_c – the force of the rack when sliding, kN; P_c^v – the vertical component of the rack force in the longitudinal plane of the support unit, should be determined at the maximum height of the support unit, kN (Fig. 1); P_c^h – the horizontal component of the P_c^v force in the transverse plane of the support unit, kN; γ – the angle of inclination of the rack relative to the base in the longitudinal plane of the support unit, deg.; β – the angle of inclination of the rack, i.e. the P_c^v forces in the transverse plane of the support unit, deg.

$$P_c = \frac{\pi \cdot D_{n.c.}^2}{4} \cdot P_n \cdot 10^3, \text{ kN},$$

where $D_{n.c}$ – the diameter of the rack piston, m; P_n – the pressure of the working fluid entering the piston cavity of the rack during the expansion period, taking into account losses, kN.

The pressure of actuation of the safety valve of the hydraulic unit of the hydraulic jack of the retractable side of the double-row shield support unit.

In contrast to the single-row shield support unit, the pressure of the safety valve of the double-row shield support unit is determined from the strut of the two struts.

At the same time:

$$P_d = 2 \cdot P_c^h = 2 \cdot P_c \cdot \cos\gamma \cdot \sin\beta, \text{ kN},$$

Pressure losses are the losses consumed for the delivery of the working fluid from the pump station to the rack.

It is recommended that the pressure of the working fluid of the P_n be determined by the indicators of pressure gauges or pressure indicators of the rack hydroblocks during the unit expansion in identical mining and geological conditions.

Thus, during the testing period of the 2KTK mechanized support unit in the face No. 3016 of JSC «SHU Obukhovskaya» the expansion of the hydraulic units was carried out with a pressure from 15.0 to 22.0 MPa, an average of 19.6 MPa when setting the pressure at the pumping station of 29 MPa. At the same time, the actuation pressure of the safety valve of the hydraulic unit of the hydraulic jack of the retractable side was 32 MPa. There was no loss of transverse stability of the support units.

Conclusion

1. The results of studies of the transverse stability of the shield powered support units and their stabilizing devices based on compression springs, a package of springs, and hydraulic jacks built into the ceiling and rear fence are presented.

2. The structure of the stabilizing device based on the use of hydraulic jacks as power elements for extending the sides of the overlap and the rear fence, with built-in safety and discharge valves, is substantiated.

3. The dependences for determining the values of the actuation pressures of the safety valves of the hydraulic jacks of the extension of the sides of the single-row and double-row of the shield powered support units on the force of the hydraulic struts are proposed.

СПИСОК ЛИТЕРАТУРЫ

1. *Якоби О.* Практика управления горным давлением. — М.: Недра, 1987. — 566 с.

2. *Коровкин Ю. А.* Механизированные крепи очистных забоев. — М.: Недра, 1990. — 414 с.

3. *Сысоев Н. И., Турук Ю. В.* Проектирование и конструирование механизированных комплексов: монография. — Новочеркасск: ЮРГПУ(НПИ), 2016. — 226 с.

4. *Докукин А. В., Коровкин Ю. А.* Механизированные крепи и их развитие. — М.: Недра, 1984. — 288 с.

5. *Kazanin O. I., Sidorenko A. A., Drebenstadt C. I.* Intensive underground mining technologies: Challenges and prospects for the coal mines in Russia // Acta Montanistica Slovaca. 2021, vol. 26, no. 1, pp. 60—69. DOI: 10.46544/AMS.v26i1.05.

6. *Brodny J.* Analysis of the impact of unscheduled downtimes on their availability in machine operations // MAPE. 2018, vol. 1, no. 1, pp. 145—151. DOI: 10.2478/mape-2018-0019.

7. *Sinha S., Chugh Y. P.* Validation of critical strain technique for assessing stability of coal mine intersections and its potential for development of roof control plans // Journal of Rock Mechanics and Geotechnical Engineering. 2018, vol. 10, no. 2, pp. 380—389.

8. *Song G., Chugh Y., Wang J.* A numerical modelling study of longwall face stability in mining thick coal seams in China // International Journal of Mining and Mineral Engineering. 2017, vol. 8, no. 1, pp. 35—55. DOI: 10.1504/IJMME.2017.082682.

9. *Szurgacz D., Brodny J.* Analysis of the influence of dynamic load on the work parameters of a powered roof support's hydraulic leg // Sustainability. 2019, vol. 11, no. 9. DOI: 10.3390/su11092570.

10. *Турук Ю. В., Сысоев Н. И., Луганцев Б. Б., Стрельцов С. В., Богомазов А. А.* Выбор типа и конструкции основания щитовых секций механизированной крепи // Горный информационно-аналитический бюллетень. — 2022. — № 8. — С. 121—134. DOI: 10.250 18/0236_1493_2022_8_0_121.

11. *Sysoev N. I., Turuk Yu. V.* Basement of structure, main power and design parameters of mechanism of removing sections of mechanized sets of knife plane installation // IOP Conference Series. Earth and Environmental Science. 2017, vol. 87, no. 2, article 022022. DOI: 10.1088/1755-1315/87/2/022022.

12. *Казанин О. И., Сидоренко А. А. Мешков А. А.* Организационно-технологические принципы реализации потенциала современного высокопроизводительного очистного оборудования // Уголь. — 2019. — № 12. — С. 4—12. DOI: 10.18796/0041-5790-2019-12-4-13.

13. *Задков Д. А., Габов В. В., Бабырь Н. В., Стебнев А. В., Теремецкая В. А.* Энергоэффективная секция механизированной крепи очистного комплекса, адаптивная к условиям эксплуатации // Горный информационно-аналитический бюллетень. — 2022. — № 6. — С. 46—61. DOI: 10.25018/0236_1493_2022_6_0_46.

14. *Buyalich G. D., Buyalich K. G., Umrikhina V. Yu.* Study of falling roof vibrations in a production face at roof support resistance in the form of concentrated force // IOP Conference Series: Materials Science and Engineering. 2016, vol. 142, no. 1, article 012120. DOI: 10.1088/1757899X/142/1/012120.

15. *Shurygin D. N., Vlasenko S. V., Turbor I. A.* An establishment of dependencies of mutual influence of geological and mining factors on the stress-strain state of the rock mass // IOP Conference Series. Earth and Environmental Science. 2019, vol. 272, no. 2, article 022235. DOI: 10.1088/1755-1315/272/2/022235.

16. *Габов В. В.* Адаптация секции, механизированной крепи совершенствованием механической характеристики гидропривода ее гидростоек // Горное оборудование и электромеханика. — 2016. — № 3. — С. 28—34.

17. *Babyr N. V., Korolev A. I.* Enhancement of powered cleaning equipment with the view of mining and geological conditions // IOP Conference Series. Earth and Environmental Science. 2018, vol. 194, no. 3, article 032004. DOI: 10.1088/1755-1315/194/3/032004.

18. *Козлов В. В.* Анализ динамики нагружения секции крепи при движении механизированного комплекса по криволинейной траектории // Уголь. — 2019. — № 12. — С. 38—39. DOI: 10.18796/0041-5790-2019-12-38-39.
19. *Szurgacz D., Brodny J.* Adapting the powered roof support to diverse mining and geological conditions // Energies. 2020, vol. 405, no. 13. DOI: 10.3390/en13020405.
20. *Хорин В. Н.* Расчет и конструирование механизированных крепей. — М.: Недра, 1988. — 256 с.
21. *Пономаренко Ю. Ф.* Расчет и конструирование гидроприводов механизированных крепей. — М.: Машиностроение, 1981. — 326 с.
22. *Szurgacz D., Brodny J.* Analysis of the influence of dynamic load on the work parameters of a powered roof support's hydraulic leg // Sustainability. 2019, vol. 11, no. 9. DOI: 10.3390/su11092570. ГИАБ

REFERENCES

1. Yakobi O. *Praktika upravleniya gornym davleniem* [Ground control practices], Moscow, Nedra, 1987, 566 p.
2. Korovkin Yu. A. *Mekhanizirovannye krepi ochistnykh zaboev* [Powered supports in production faces], Moscow, Nedra, 1990, 414 p.
3. Sysoev N. I., Turuk Yu. V. *Proektirovanie i konstruirovanie mekhanizirovannykh kompleksov: monografiya* [Design and engineering of mechanized longwall mining systems: Monograph], Novocherkassk, YURGPU(NPI), 2016, 226 p.
4. Dokukin A. V., Korovkin Yu. A. *Mekhanizirovannye krepi i ikh razvitie* [Powered supports and their improvement], Moscow, Nedra, 1984, 288 p.
5. Kazanin O. I., Sidorenko A. A., Drebenstadt C. I. Intensive underground mining technologies: Challenges and prospects for the coal mines in Russia. *Acta Montanistica Slovaca*. 2021, vol. 26, no. 1, pp. 60—69. DOI: 10.46544/AMS.v26i1.05.
6. Brodny J. Analysis of the impact of unscheduled downtimes on their availability in machine operations. *MAPE*. 2018, vol. 1, no. 1, pp. 145—151. DOI: 10.2478/mape-2018-0019.
7. Sinha S., Chugh Y. P. Validation of critical strain technique for assessing stability of coal mine intersections and its potential for development of roof control plans. *Journal of Rock Mechanics and Geotechnical Engineering*. 2018, vol. 10, no. 2, pp. 380—389.
8. Song G., Chugh Y., Wang J. A numerical modelling study of longwall face stability in mining thick coal seams in China. *International Journal of Mining and Mineral Engineering*. 2017, vol. 8, no. 1, pp. 35—55. DOI: 10.1504/IJMME.2017.082682.
9. Szurgacz D., Brodny J. Analysis of the influence of dynamic load on the work parameters of a powered roof support's hydraulic leg. *Sustainability*. 2019, vol. 11, no. 9. [In Russ]. DOI: 10.3390/ su11092570.
10. Turuk Yu. V., Sysoev N. I., Lugantsev B. B., Streltsov S. V., Bogomazov A. A. Selection of the type and design of the shield base of powered support units. *MIAB. Mining Inf. Anal. Bull.* 2022, no. 8, pp. 121—134. [In Russ]. DOI: 10.25018/0236_1493_2022_8_0_121.
11. Sysoev N. I., Turuk Yu. V. Basement of structure, main power and design parameters of mechanism of removing sections of mechanized sets of knife plane installation. *IOP Conference Series. Earth and Environmental Science*. 2017, vol. 87, no. 2, article 022022. DOI: 10.1088/1755-1315/87/2/022022.
12. Kazanin O. I., Sidorenko A. A. & Meshkov A. A. Organizational and technological principles of realization of the modern high productive longwall equipment capacity. *Ugol'*. 2019, no. 12, pp. 4—12. [In Russ]. DOI: 10.18796/0041-5790-2019-12-4-13.
13. Zadkov D. A., Gabov V. V., Babyr N. V., Stebnev A. V., Teremetskaya V. A. Adaptable and energy-efficient powered roof support unit. *MIAB. Mining Inf. Anal. Bull.* 2022, no. 6, pp. 46—61. [In Russ]. DOI: 10.25018/0236_1493_2022_6_0_46.

14. Buyalich G. D., Buyalich K. G., Umrikhina V. Yu. Study of falling roof vibrations in a production face at roof support resistance in the form of concentrated force. *IOP Conference Series: Materials Science and Engineering*. 2016, vol. 142, no. 1, article 012120. DOI: 10.1088/1757899X/142/1/012120.

15. Shurygin D. N., Vlasenko S. V., Turbor I. A. An establishment of dependencies of mutual influence of geological and mining factors on the stress-strain state of the rock mass. *IOP Conference Series. Earth and Environmental Science*. 2019, vol. 272, no. 2, article 022235. DOI: 10.1088/1755-1315/272/2/022235.

16. Gabov V. V. Adaptation of powered support unit by improving the speed-torque characteristics of the hydraulic prop drive. *Mining Equipment and Electromechanics*. 2016, no. 3, pp. 28—34. [In Russ].

17. Babyr N. V. , Korolev A. I. Enhancement of powered cleaning equipment with the view of mining and geological conditions. *IOP Conference Series. Earth and Environmental Science*. 2018, vol. 194, no. 3, article 032004. DOI: 10.1088/1755-1315/194/3/032004.

18. Kozlov V. V. Loading dynamics of the powered support unit during movement of longwall mining system along a curved trajectory. *Ugol'*. 2019, no. 12, pp. 38—39. [In Russ]. DOI: 10.18796/0041-5790-2019-12-38-39.

19. Szurgacz D., Brodny J. Adapting the powered roof support to diverse mining and geological conditions. *Energies*. 2020, vol. 405, no. 13. DOI: 10.3390/en13020405.

20. Khorin V. N. *Raschet i konstruirovanie mekhanizirovannykh krepey* [Calculation and design of mechanized supports], Moscow, Nedra, 1988, 256 p.

21. Ponomarenko Yu. F. *Raschet i konstruirovanie gidroprivodov mekhanizirovannykh krepey* [Calculation and design of hydraulic drives of mechanized supports], Moscow, Mashinostroenie, 1981, 326 p.

22. Szurgacz D., Brodny J. Analysis of the influence of dynamic load on the work parameters of a powered roof support's hydraulic leg. *Sustainability*. 2019, vol. 11, no. 9. DOI: 10.3390/su11092570.

ИНФОРМАЦИЯ ОБ АВТОРАХ

Турук Юрий Владимирович[1] — д-р техн. наук,
доцент, профессор, e-mail: uraturuk@mail.ru,
ORCID ID: 0000-0002-4257-0744,
Сысоев Николай Иванович[2] — д-р техн. наук,
профессор, e-mail: sysoevngmo@gmail.com,
ORCID ID: 0000-0002-0372-427X,
Луганцев Борис Борисович[2] — д-р техн. наук,
доцент, профессор, e-mail: boris4721@mail.ru,
ORCID ID: 0000-0002-8296-7922,
Стрельцов Сергей Владимирович[1] — канд. техн. наук,
доцент, e-mail: streltcov_s@rambler.ru,
ORCID ID: 0000-0003-4989-4327,
Богомазов Александр Александрович[1] — канд. техн. наук,
доцент, e-mail: sbog@rambler.ru,
ORCID ID: 0000-0002-7176-3393,
[1] Шахтинский автодорожный институт (филиал)
Южно-Российского государственного политехнического
университета (НПИ) имени М.И. Платова,
[2] Южно-Российский государственный политехнический
университет (НПИ) имени М.И. Платова.
Для контактов: Турук Ю.В., e-mail: uraturuk@mail.ru.

INFORMATION ABOUT THE AUTHORS

Yu.V. Turuk[1], Dr. Sci. (Eng.),
Assistant Professor, Professor,
e-mail: uraturuk@mail.ru,
ORCID ID: 0000-0002-4257-0744,
N.I. Sysoev[2], Dr. Sci. (Eng.), Professor,
e-mail: sysoevngmo@gmail.com,
ORCID ID: 0000-0002-0372-427X,
B.B. Lugantsev[2], Dr. Sci. (Eng.),
Assistant Professor,
Professor, e-mail: boris4721@mail.ru,
ORCID ID: 0000-0002-8296-7922,
S.V. Streltsov[1], Cand. Sci. (Eng.),
Assistant Professor,
e-mail: streltcov_s@rambler.ru,
ORCID ID: 0000-0003-4989-4327,
A.A. Bogomazov[1], Cand. Sci. (Eng.),
Assistant Professor, e-mail: sbog@rambler.ru,
ORCID ID: 0000-0002-7176-3393,
[1] Shakhty Road Institute, Branch of Platov
South-Russian State Polytechnic University (NPI),
346500, Shakhty, Russia,
[2] Platov South-Russian State Polytechnic
University (NPI), 346428, Novocherkassk, Russia.
Corresponding author: Yu.V. Turuk, e-mail: uraturuk@mail.ru.

Получена редакцией 15.12.2022; получена после рецензии 27.02.2023; принята к печати 10.03.2023.
Received by the editors 15.12.2022; received after the review 27.02.2023; accepted for printing 10.03.2023.

Неделя горняка-2023