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Satbayev University

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ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ
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INTERRELATION OF PERFORMANCE INDICATORS OF TECHNOLOGICAL TRANSPORT WITH MINING CONDITIONS OF A QUARRY

Abstract. The article discusses and substantiates the relationship of technical characteristics, namely, the load capacity of dump trucks, where a regular increase in the depth of the quarry and the volume of rock mass can be traced. At the same time, the dependence of the volume of the rock mass on the load capacity of the dump truck is close to linear, which means that with an increase in volume by 1 t (1 m^3), the change in its load capacity is constant. The main indicators in assessing the degree of use of dump trucks is the distance of transportation, taking into account the horizontal movement and lifting of rock mass from the quarry. According to the results of the established dependence of the operational speed, as well as the number of flights from the given distance, a reference performance of dump trucks is obtained, which serves to determine the performance of dump trucks

To date, worldwide differences in technological transport schemes by operating enterprises will mainly continue to use existing modes of transport with the introduction of new transport systems on certain sections of the quarry, mainly on deep horizons, and secondly, more modern ones are used. In this regard, there is a need to carry out scientific research on modeling the operation of heavy-duty road transport taking into account its indicators, to study the influence of the parameters of a deep quarry on the choice of technological schemes for transporting rock mass, to develop effective ways of managing the working area.

A number of scientific and practical works have been carried out in the Republic on

the development of methods and means of adaptation of cyclic-flow technology, the formation of a transport system of deep quarries by technological modules when using a modular crushing and transshipment point, new technological schemes and parameters of cyclic-flow technology have been developed. The performance of dump trucks largely depends on the distance of transportation, the average daily duration of work and the utilization factor of calendar time. Indicators of technological road transport development include the average number of cars (by brand), the load capacity of the dump truck fleet and the average load capacity of one average dump truck.

Each of these indicators is established by a simple summation of the corresponding shift, daily, monthly work results based on the existing accounting of the work of road transport. Correlation and regression analyses were used to process the data using the least squares method.

Key words: quarry, transport, energy intensity, calculation, calculation, process, method, trucking, assessment, loading, unloading, maneuver, period, waiting, mining.

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ТЕХНОЛОГИЯЛЫҚ КӨЛІК КӨРСЕТКІШТЕРІНІҢ КАРЬЕРДІҢ ТАУ-КЕН ТЕХНИКАЛЫҚ ЖАҒДАЙЛАРЫМЕН БАЙЛАНЫСЫ

Аннотация. Мақалада техникалық сипаттамалардың, атап айтқанда, карьердің тереңдігі мен тау-кен массасының көлемінің табиғи өсуі байқалатын автосамосвалдардың жүк көтергіштігінен өзара байланысы қарастырылады және негізделеді. Бұл ретте тау массасы көлемінің автосамосвалдың жүк көтергіштігіне тәуелділігі сызықтыққа жақын, бұл дегеніміз – көлем 1 т (1м^3) ұлғайған кезде оның жүк көтергіштігінің өзгеруі тұрақты болады. Автосамосвалдарды пайдалану дәрежесін бағалаудағы негізгі көрсеткіштер карьерден тау массасының көлденең қозғалысы мен көтерілуін ескеретін тасымалдау қашықтығы болып табылады. Пайдалану жылдамдығының белгіленген тәуелділігінің, сондай-ақ берілген қашықтыққа рейстер санының нәтижелері бойынша автосамосвалдардың өнімділігін анықтауға қызмет ететін автосамосвалдардың эталондық өнімділігі алынады.

Бүгінгі таңда бүкіл әлемде технологиялық көлік схемаларындағы айырмашылықтар жұмыс істеп тұрған кәсіпорындар негізінен карьердің жекелеген учаскелерінде, негізінен терең көкжиектерде, жаңа көлік жүйелерін енгізе отырып, қолданыстағы көлік түрлерін пайдалануды жалғастырады, екіншіден, қазіргі заманғы көлік жүйелерін пайдаланады. Осыған байланысты оның көрсеткіштерін ескере отырып, ауыр салмақты автомобиль көлігінің жұмысын

модельдеу бойынша ғылыми зерттеулер жүргізу, тау-кен массасын тасымалдаудың технологиялық схемаларын таңдауға терең Карьер параметрлерінің әсерін зерттеу, жұмыс аймағын басқарудың тиімді әдістерін жасау қажеттілігі туындайды.

Республикада циклдік-ағындық технологияны бейімдеу әдістері мен құралдарын әзірлеу, терең карьерлердің көлік жүйесін қалыптастыру бойынша бірқатар ғылыми-тәжірибелық жұмыстар орындалды.

Түйінді сөздер: карьер, көлік, энергия сыйымдылығы, есептеу, есептеу, процесс, әдіс, жүк тасымалдау, бағалау, тиеу, түсіру, маневр, кезең, күту, тау-кен өндіру.

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ВЗАИМОСВЯЗЬ ПОКАЗАТЕЛЕЙ РАБОТЫ ТЕХНОЛОГИЧЕСКОГО ТРАНСПОРТА С ГОРНОТЕХНИЧЕСКИМИ УСЛОВИЯМИ КАРЬЕРА

Аннотация. В статье рассмотрены и обоснованы взаимосвязь технических характеристик, а именно от грузоподъёмности автосамосвалов, где прослеживается закономерный рост глубины карьера и объёма горной массы. При этом зависимость объёма горной массы от грузоподъёмности автосамосвала близка к линейной, это значит – при приращении объёма на 1 т (1м^3) изменение грузоподъёмности его постоянна. Основными показателями при оценке степени использования автосамосвалов является расстояние транспортирования, учитывающее горизонтальное перемещение и подъем горной массы из карьера. По результатам установленной зависимости эксплуатационной скорости, а также количества рейсов от приведенного расстояния получают эталонную производительность автосамосвалов, служащая для определения производительности автосамосвалов.

На сегодняшний день во всем мире различия в технологических транспортных схемах действующими предприятиями будут в основном продолжать использоваться действующие виды транспорта с внедрением на отдельных участках карьера, главным образом, на глубинных горизонтах, новых транспортных систем, во-вторых, используют более современные. В связи с этим возникает необходимость в выполнении научных исследований по моделированию работы большегрузного автомобильного транспорта с учетом его показателей, исследование влияния параметров глубокого карьера на выбор технологических схем транспортирования горной массы, разработке эффективных способов управления рабочей зоной.

В республике выполнен ряд научно-практических работ по разработке методов и средств адаптации циклично-поточной технологии, формирование транспортной системы глубоких карьеров технологическими модулями при

применении модульного дробильно-перегрузочного пункта, разработаны новые технологические схемы и параметры циклично-поточной технологии. Производительность автосамосвалов в значительной степени зависит от расстояния перевозок среднесуточной продолжительности работы и коэффициента использования календарного времени. Показатели развития технологического автомобильного транспорта включают среднесписочное число автомобилей (по маркам), грузоподъемность парка автосамосвалов и среднюю грузоподъемность одного среднесписочного автосамосвала.

Каждый из этих показателей устанавливается простым суммированием соответствующих сменных, суточных, месячных результатов работы на основе имеющегося учета работы автомобильного транспорта. Для обработки данных с использованием метода наименьших квадратов использованы корреляционный и регрессионный анализы.

Ключевые слова: карьер, транспорт, энергоемкость, расчет, расчет, процесса, метод, автоперевозка, оценка, погрузка, разгрузка, маневр, период, ожидания, горные работы.

Introduction. Transportation of rock very both in the initial period of development of a quarry and as its depth grows, is one of the main most labor-intensive processes of open mining of solid mineral deposits.

With an increase in the depth of work when using cyclic and cyclic-flow quarry transport, the tasks of maintaining the high productivity of the quarry in terms of rock mass, as well as maintaining the rate of decrease in mining operations, inevitably and largely arise. In this connection, studies of the choice of effective and safe technological schemes for transporting rock mass are aimed at determining the relationship between the performance of several types of technological transport, intensification of mining and stripping operations under deteriorating mining conditions in a quarry.

An intensive increase in the depth of open-pit mining required a study of the influence of the mining conditions of open pits on the performance of technological transport. In this case, the indicator of the depth of open pits is decisive (Naimova et al., 2022: 2432).

Modern technology and world experience in open pit mining is represented by a wide range of machines and mechanisms. At the same time, the technical support of open pit mines mainly aimed at the use of high-performance mechanization tools with the maximum compliance of the operating parameters of the equipment with the natural and mining conditions of the deposits and their rational combination during their associated work at deep horizons, increasing unit capacity and operational reliability.

Results and Discussion. Figure 1 shows the main factors that determine the choice of transport schemes in deep pits, which differ from those previously taken into account in that their ability to determine, largely, the technical and economic indicators of deep pit development, taken as the main criterion. All factors affecting the production capacity of quarries with an increase in their depth divided into mining and geological, mining engineering, economic.

In many works, the main mining and technical factors in the development of deep

pits identified, which are widely used in various variations of the transport scheme (Raupova et al., 2014: 76–85.).

1. In quarries with a depth of 150-200 m, mining dump trucks are used as the main and assembly equipment, and when using them, the following factors must be taken into account: the ratio of production capacities, the location of reserves relative to the contours of the quarry, the availability of work sites in the quarry in order to create a rock warehouse, and others.

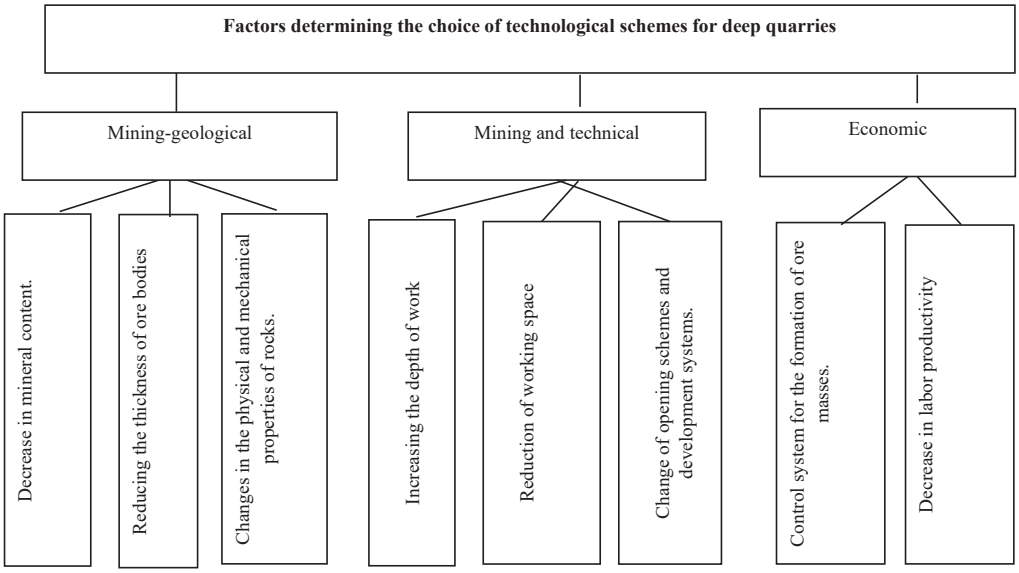


Fig. 1. Factors determining the choice of transport schemes for deep quarries.

2. When using automobile-conveyor transport of ore in quarries, taking into account its depth and productivity, which can be used in the initial period and after deepening the quarry (Makhmudov et al., 2022).

3. Automobile-conveyor-rail transport, which is mostly common in foreign quarries, with a distinctive feature of their use without intra-quarry excavator warehouses. In turn, the rock is loaded directly from the faces into the trains located in the underground tunnels located under the warehouse.

4. The technological scheme road transport-ore pass-crusher-conveyor is very widespread and is used in quarries in Sweden, the USA, and Mexico.

5. Technological schemes of combined automobile-skip-railway, automobile-skip-road transport are used in quarries with limited dimensions of 100-200 m, with a capacity of 8-10 million tons of ore per year.

The variability of the mining and geological characteristics of rock deposits significantly affects the efficiency of mining, significantly complicating the choice of technological parameters for transport and other mining processes (Hayitov et al., 2020).

The mining and technical conditions of the operation of technological transport at the Muruntau quarry presented in Table 1 show that in the first years of operation it was

possible significantly increase the rate of deepening and the length of transportation by road by 2.5 km at a lifting height of 80-100 m.

An important feature of mining engineering factors is that, unlike natural ones, they are manageable within a certain range of change. Technological factors are characterized by a close relationship and have common changes with the depth of development in different quarries (Umarova et al., 2021).

Table 1

Mining and technical conditions for the operation of technological transport of the Muruntau quarry

Index	YEAR									
	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015
Quarry depth, m	50	80	140	180	250	305	360	420	555	580
Distance of transportation by road, km										
- in the dump	2,5	2,7	2,8	4	4,9	5,3	6,5	7,7	2,76	3,36
-up to DPP CPT (without KNK-270)	-	-	-	1,6	2,2	2,6	2,8	3	2,57	2,48
Career average.	2,5	2,7	2,8	3,5	3,4	3,9	4,5	5,7	3,33	3,44
Lifting height of rock mass by motor transport, m										
- in the dump	15	54	65	127	145	195	240	280	120,3	146,3
-up to DPP CPT (without KNK-270)	-	-	-	29	34	67	70	95	37,6	74,9
Career average	15	54	65	110	107	119	130	165	141,6	153,3

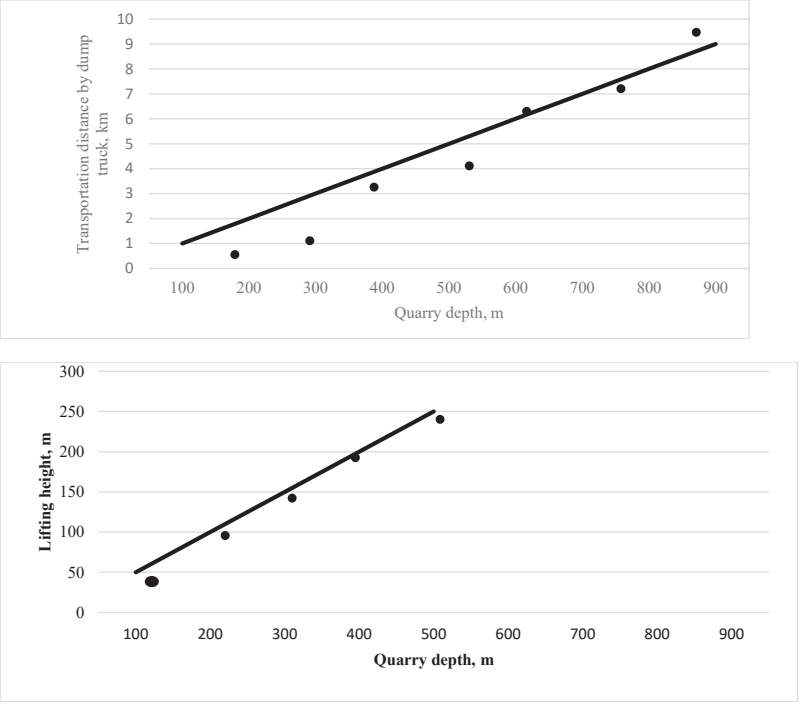


Fig.2. The relationship of transportation distance and lifting height with the depth of the quarry

An intensive increase in the depth of open-pit mining required a study of the influence of mining conditions in quarries on the performance of technological vehicles. In this case, the indicator of the depth of open pits is decisive. The given actual indicators of the mining conditions of the Muruntau open pit (see Table 1) made it possible to obtain a graphical interpretation of the indicators of technological transport with the depth of the open pit (Fig. 2).

The processing of the obtained data made it possible to obtain dependences that indicate a constant deterioration in the mining conditions for the operation of technological transport, accompanied by an increase in the distance of transportation and an increase in the height of the rock mass from the lower zones of the open pit.

An analysis of the increase in the depth of open pits showed that as they develop, the distance of transportation and the height of the rock mass rise increase. At the same time, the situation is complicated by the fact that mineral deposits that are complex in terms of their qualitative composition and geological structure are involved in the development. It should be noted that the growth in ore mining and the decline in the volume of mined rock mass led to the complication of mining conditions in the quarry. When ore is mined from deep open pits (the open pit is more than 600 meters deep) and the largest possible volumes of rock mass movement per year of mining, the work on their transportation increases significantly. In these modes of operation of deep pits, the cost of transporting rock mass is 60% or more. In this regard, additional studies were carried out in order to identify patterns of influence on them of the volume of rock mass extracted from the Muruntau quarry by mining and transport equipment.

The profitability of the open pit mining in its lower zones is ensured with the right choice of mining and transport equipment, opening, as well as the stability parameters of the open pit walls. During the development of the Muruntau quarry, several rational innovations were implemented that were aimed at optimizing mining operations and reducing costs: the use of cyclic-flow technology; use of dump trucks with a carrying capacity from 27 tons to 40, 75, 130, 180, 220 tons for moving quarry cargo; with electric excavators with buckets with a capacity of 4 to 12 m^3, as well as hydraulic excavators with a capacity of 15 to 20 m^3; application of steeply inclined KNK conveyors (Norov et al., 2018).

Using the results obtained, the parameters of a deep open pit with the technical capabilities of dump trucks with a carrying capacity of 170-200 tons were studied and investigated. For a more detailed study, the main parameters of the open pit were taken into account (Table 2).

Table 2 - Estimated technical and technological parameters of the Muruntau open pit.

Parameter	Meaning				
Indicators	Quarry demotion queues				The prospect is the 5th stage until 2025.
	1-st 1967-1971y	2-nd 1972-1976y	3-rd 1977-1995y	4-th since 1996	
Absolute marks, m	+345	+200	+100	-75	-
Quarry depth, m	170	300	490	575	735-1000

Volume of rock mass, $10^6 m^3$	169	602	845	1362	1600
Productivity in terms of rock mass, million m^3/year	8,0	24,0	41,08	50	55
Side slope angle, degrees	0	15	15-38	35-40	40-45
Distance of transportation by dump trucks, km	2,6	3,4	3,0-3,2	3,0-3,5	3,0-4,8
Excavator bucket capacity, m^3	4,6	8-15	12-17	12-17	20
Loading capacity of a dump truck, t	27-40	75-140	140-170	140-170	180
Maximum slope of technological roads in the working area, %	8-10	8-10	8-10	8-10	15-20
Transport berm width, m	38	38	20	20	20

The initial data were the technical parameters of the dump truck and its movement in different areas of the quarry in accordance with the rules and regulations.

The performed calculations (Table 2, Fig. 3, 4) made it possible to establish the relationship between technical characteristics, namely, the load capacity of dump trucks, where a regular increase in the depth of the quarry and the volume of rock mass can be traced. At the same time, the dependence of the volume of the rock mass on the load capacity of the dump truck (Fig. 4) is close to linear, which means that with an increase in volume by 1 t (1 m3), the change in its load capacity is constant.

Fig. 3. Dependence of the volume of rock mass on the depth of the quarry

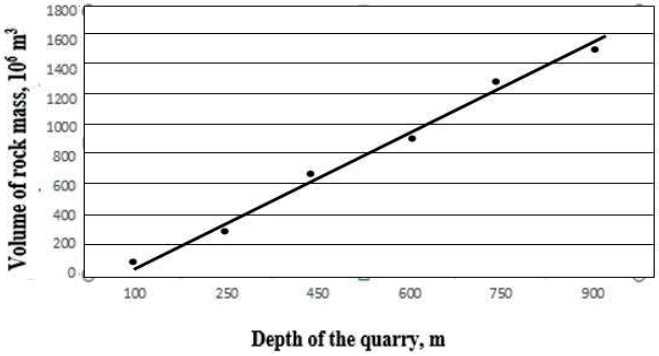
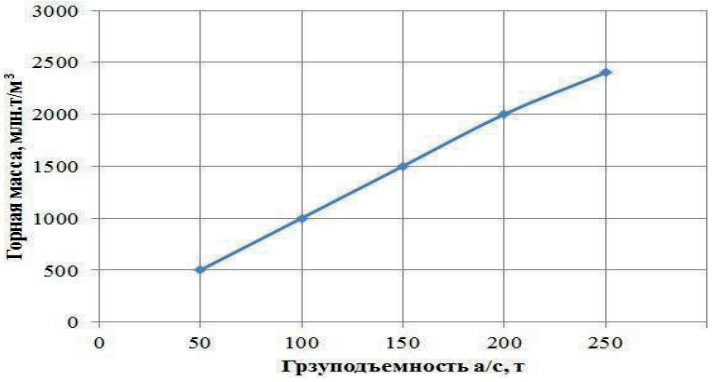


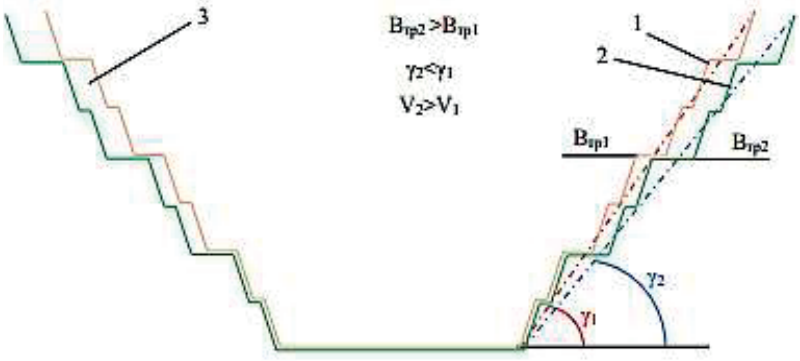
Fig. 4. Dependence of the volume of rock mass on the load capacity of a dump truck



It is known that the volume of the quarry, the current and average-stripping ratio directly depend on the selected dump truck. In this regard, in order to select mining and transport equipment for the conditions of the deposit, studies and calculations of the volumes of extracted rock mass were carried out; dependences of the influence on certain sections of the wall of the Muruntau quarry were established.

The increase in the volume of the open pit with a change in the carrying capacity used when moving the rock mass by a dump truck depends on the angle of slope of the sides of the open pit (Fig. 5).

Fig.5. Boundary of a deep pit with transport berms of different widths



1 - quarry boundary with a narrow transport berm; 2- open pit fenders with a wide transport berm; 3 - additionally extracted volume of rocks in the open pit with an increase in the width of the berms.

The selected angles of the working and non-working sides of the quarry must meet the requirements for safe mining, the stability of the sides and the conditions for placing transport communications and platforms on the sides. In this case, the slope angle of the pit wall can be determined by the empirical formula:

$$tg\beta = \frac{H}{\sum B_m + b_n + b_{km} + \sum H_y \cdot ctg\alpha}, \text{ hail} \qquad (1)$$

Where $B_т$ - transport berm width, m;
$b_п$ - berm preservative width, m;
b_{km} - the width of the capital trench located on board, m;
H - open pit wall height, m;
H_y - ledge height, m;
α – angle of stable slope of ledge, hail.

Since the angle of slope of the working side of the open pit significantly affects the current stripping ratio (Fig. 6, 7) on the technical and economic performance of a deep open pit, it will be most economical to lower mining operations by the maximum elevation of the working side of the open pit and the minimum productivity of the excavator-automobile complex (Sytenkov et al., 2003: 153).

The obtained dependencies show an increase in the angle of the working side of the

open pit with an increased current stripping ratio, which can be used as the basis for choosing heavy-duty mining equipment for deep open pit conditions.

When mining inclined and steep deposits, safety and transport berms should be located on the non-working side of the quarry.

Fig. 6. Dependence of the current stripping ratio on the angle of the open pit-working wall

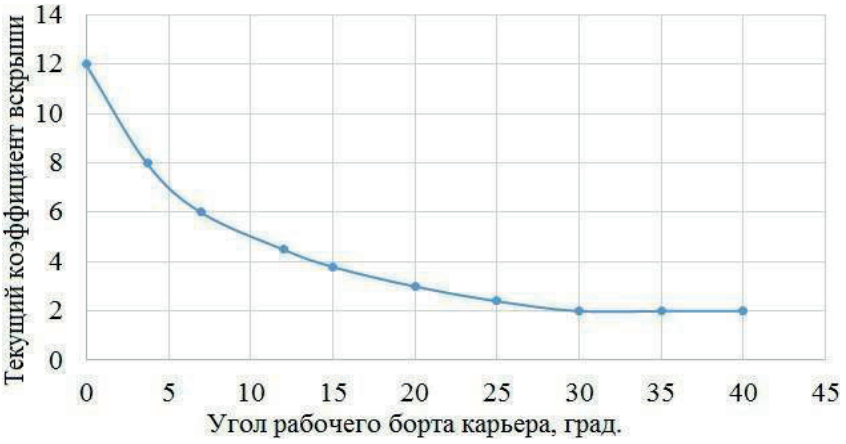
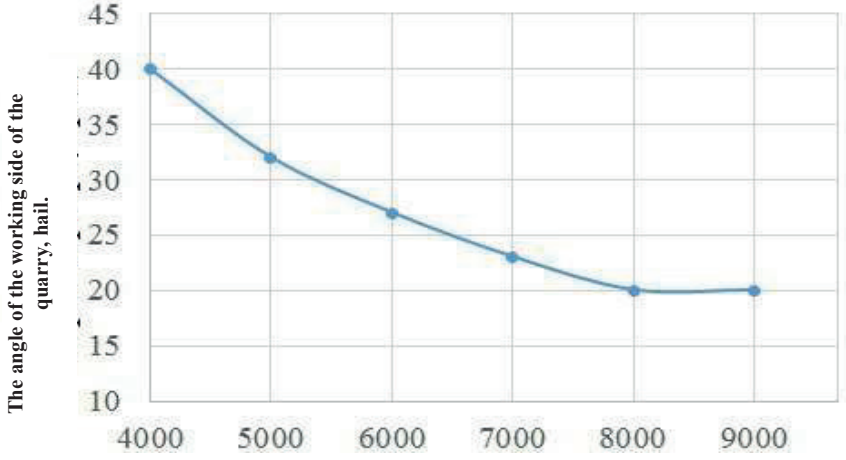


Fig. 7. Dependence of the angle of the working side of the quarry on the performance of the automobile-excavator complex.



According to its intended purpose, the transport berm serves to accommodate transport routes connecting the working platforms of ledges with capital trenches. The type of transport used, the intensity of the rock mass traffic along it, etc determine the width of the transport berm. A transport berm connecting several ledges is called a connecting berm. Part of the upper platform of the ledge with a width equal to the base of the collapse prism is called a safety berm, while equipment, transport routes, power lines are placed outside the safety berm (Bye et al., 1999).

A safety berm is necessary to increase stability and reduce the angle of slope of the pit wall and to protect the located lower ledges from accidental falling of rock pieces. The safety berm is usually at least wide enough to accommodate equipment on the berm for loading and handling rolled rock.

Studies have established that such a factor as the overall dimensions of a dump truck are not taken into account well, and it is this factor that determines the width of the transport berm, which in turn affects the design of the side of a deep pit and, accordingly, the volume of extracted rock mass.

For the conditions of the Muruntau quarry, mining dump trucks of the BELAZ brand with a carrying capacity of 136-220t, CAT-785V with a carrying capacity of 170t are used for transporting rock mass (Raupova et al., 2014: 76.).

In the research, a dump truck with a carrying capacity of 200 tons was considered, since the calculation of the distance for transporting rock mass from a quarry to the surface is carried out with a slope of roads and the number of flat sections by CAT-785V dump trucks.

Analyzing the above, according to the results of the research it was found that the volume of mining operations consists of two interrelated parts - volumes that ensure current production for the unconditional fulfillment of the established gold output and timely preparation of mining sites for subsequent periods of mining. Thus, the studies carried out allow us to conclude that the dimensions of dump trucks and the width of transport berms are equal, leading to an increase in the volume of the quarry (Fang et al., 2016: 869).

Fig. 8. Dependence of the width of the transport berm on the width of a mining truck.

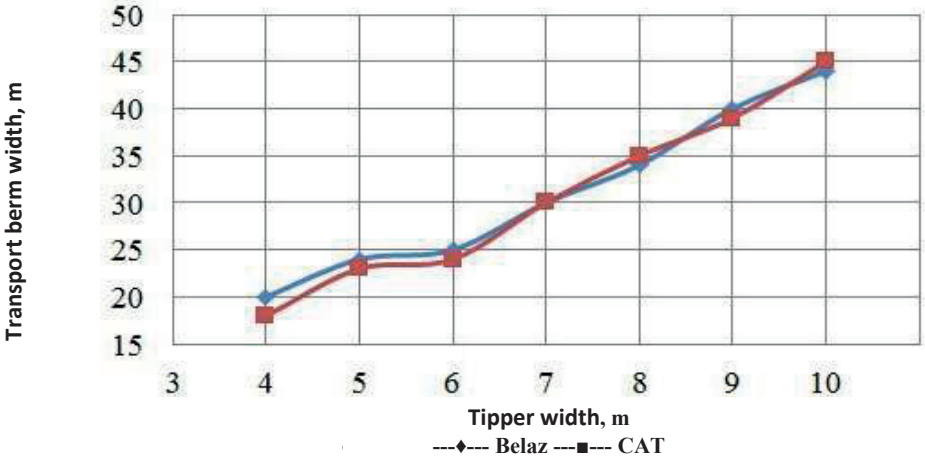
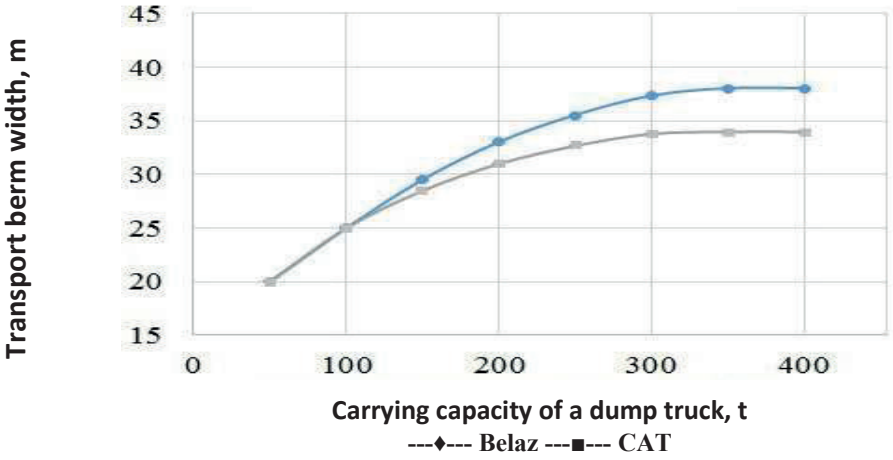


Fig. 9. Dependence of the width of the transport berm on the load capacity of the dump truck



Conclusion. On the basis of the conducted researches it was established:

1. One of the important tasks of rational, integrated and safe open pit mining is the development and improvement of open pit transport. In solving this problem, a special place is occupied by the study of mining technical factors and the justification of the strategy for the formation of mining transport systems of deep open pits.

2. As the quarry develops in depth, the distance of transportation and the height of the rock mass rise increase, therefore, while maintaining the annual production volumes, the labor intensity of its transportation increases, which will require a change in the scheme for transporting the rock mass at the lower horizons.

3. The operating parameters of the power plant of a mining dump truck directly affect the performance and efficiency of the rock mass transportation process. With an increase in the lifting height of the rock mass, the duration of the operation of the power plant of a mining dump truck at maximum loads increases, which leads to an increase in the specific fuel consumption, intensive wear of the parts of the main units, and as a result, a decrease in their resource, an increase in downtime for repairs and maintenance, a decrease in the CTG and rising costs for repairs and spare parts, etc.

4. When developing technological schemes for transporting rock mass using heavy-duty dump trucks, it was found that in the deep part of the quarry, the introduction of an excavator-automobile complex makes it possible to improve their work and increase their productivity, when comparing their geometric and energy-power parameters.

Thus, the substantiation of the energy efficiency of technological processes and transport systems of deep quarries when using dump trucks with a large carrying capacity shows the effectiveness of the decisions made.

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REFERENCES

Akhmedov N.A. Problems of geology and development of the mineral resource base. //Proceedings of int. Scientific-practical. conference "Problems of ore deposits and improving the efficiency of geological exploration." - Tashkent. 2003 - S. 8-11

Aristov I.I., Snitka N.P. Improving the methodology of rationing and accounting for losses and impoverishment of ore // Mining Journal: - 2007 - No. 5. - Pp.73-77

Braun T., Hennig A., Lottermoser B. G. The need for sustainable technology diffsion in mining: Achieving the use of belt conveyor systems in the German hard-rock quarrying industry // Journal of Sustainable Mining. 2017 Vol. 16. Iss. 1. Pp. 24–30

Bye A.R., Jermy C.A., Bell F.G. Slope optimization and review of the geotechnical conditions at Sandsloot open pit. - Proceedings of Ninth International Congress on Rock; Mechanics, Vol. 2, theme 1: Applied rock mechanics - Safety and control of the environment. - Rotterdam, 1999

Fang N., Ji C., Crusoe G.E. Stability analysis of the sliding process of the west slope in Buzhaoba Open-Pit Mine // International Journal of Mining Science and Technology. 2016. Vol. 26. Iss. 5. Pp. 869–875

Hayitov O.G., Yusupkhodzhaeva E.N., Abdurakhmanova S.P. & Holmatova N.G. (2020). On the state of hydrocarbon resource base in the beshkent trough. Journal of Advanced Research in Dynamical and Control Systems, 12(7 Special Issue), 2327-2332. doi:10.5373/JARDCS/V12SP7/20202360

Raupova O., Kamahara H., Goto N. Assessment of physical economy through economywide material flw analysis in developing Uzbekist an // Resources, Conservation and Recycling. 2014. Vol. 89. Pp. 76–85.

Makhmudov I., Sadiev U., Lapasov K., Ernazarov A. & Rustamov S. (2022). Solution of the filter flow problem by analytical and numerical methods. Paper presented at the AIP Conference Proceedings, 2432 doi:10.1063/5.0090359 Retrieved from

Makhmudov I., Sadiev U. & Rustamov S. (2022). Basic conditions for determining the hydraulic resistance to friction in a pipeline when a mixture of water and suspended sediments moves. Paper presented at the AIP Conference Proceedings, 2432 doi:10.1063/5.0090349 Melnikov N.N., Reshetnyak S.P. Prospects for solving scientific problems in the development of powerful deep quarries // Mining: IGD SB RAS. - Yakutsk, 1994. - S. 14-23.

Naimova R., Karimov S., Kushshayev U. & Olmasova M. (2022). Applications of economic and mathematical modeling in the organization of transportation of rock mass in deep quarries. Paper presented at the AIP Conference Proceedings, 2432 doi:10.1063/5.0089595

Naimova R.S. & Raimjanov B.R. (2020). Process flow chart for high dumping by stacking conveyors on nonuniform base. Mining Informational and Analytical Bulletin, 2020(79), 125-136. doi:10.25018/0236-1493-2020-9-0-125-136

Norov Y.D., Nasirov U.F. & Ochilov S.A. (2018). Investigation and development of high-bench blasting method with parallel close-spaced holes and wedging stemming. Gornyi Zhurnal, (9), 42-45. doi:10.17580/gzh.2018.09.04

Slope Stability in Surface Mining - Littleton, Colorado, USA. Publ. by S.M.E. — 2001

Sytenkov V.N., Shemetov P.A. Improving the management efficiency of the excavator-automobile complex in deep pits / / "Ecology and nature management": Sat. scientific papers of the Institute of Problems of Nature Management and Ecology of the National Academy of Sciences of Ukraine. -Vol.5. Dnepropetrovsk, 2003. - Pp.153-159

Sanakulov K.S. Shemetov P.A. The Muruntau quarry on the way to a record depth: the main stages of development and modernization of mining // Mining Journal. - 2009 - No. 11. - Pp. 98-102

Shohruh Sh.Y. & Abduraxim A.K. (2021). INVESTIGATION OF THE QUALITATIVE, PHYSICOCHEMICAL AND MINERALOGICAL PROPERTIES OF THE RAW MATERIAL INDEX OF MINERAL LINING BRICKS. Middle European Scientific Bulletin, 17, 23-40. Retrieved from

Umarova I., Matkarimov S., Bekpulatov J., Makhmaredjabov D. & Yuldashev S. (2021). Study of the form of minerals in copper porphyry ores of «Yoshlik-I» deposit. Paper presented at the E3S Web of Conferences, 304 doi:10.1051/e3sconf/202130402003

Umarova I.K., Makhmarezhabov D.B. & Yuldashev S.K. (2021). Material composition analysis and process flow development for the porphyry copper ores of the yoshlik-1 deposit. Obogashchenie Rud, (5), 10-14. doi:10.17580/or.2021.05.02

Umarova I.K., Matkarimov S.T. & Makhmarezhabov D.B. (2020). Development of a flotation technology for gold-bearing ores of the amantaytau deposit. Obogashchenie Rud, 2020(2), 29-33. doi:10.17580/or.2020.02.05

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