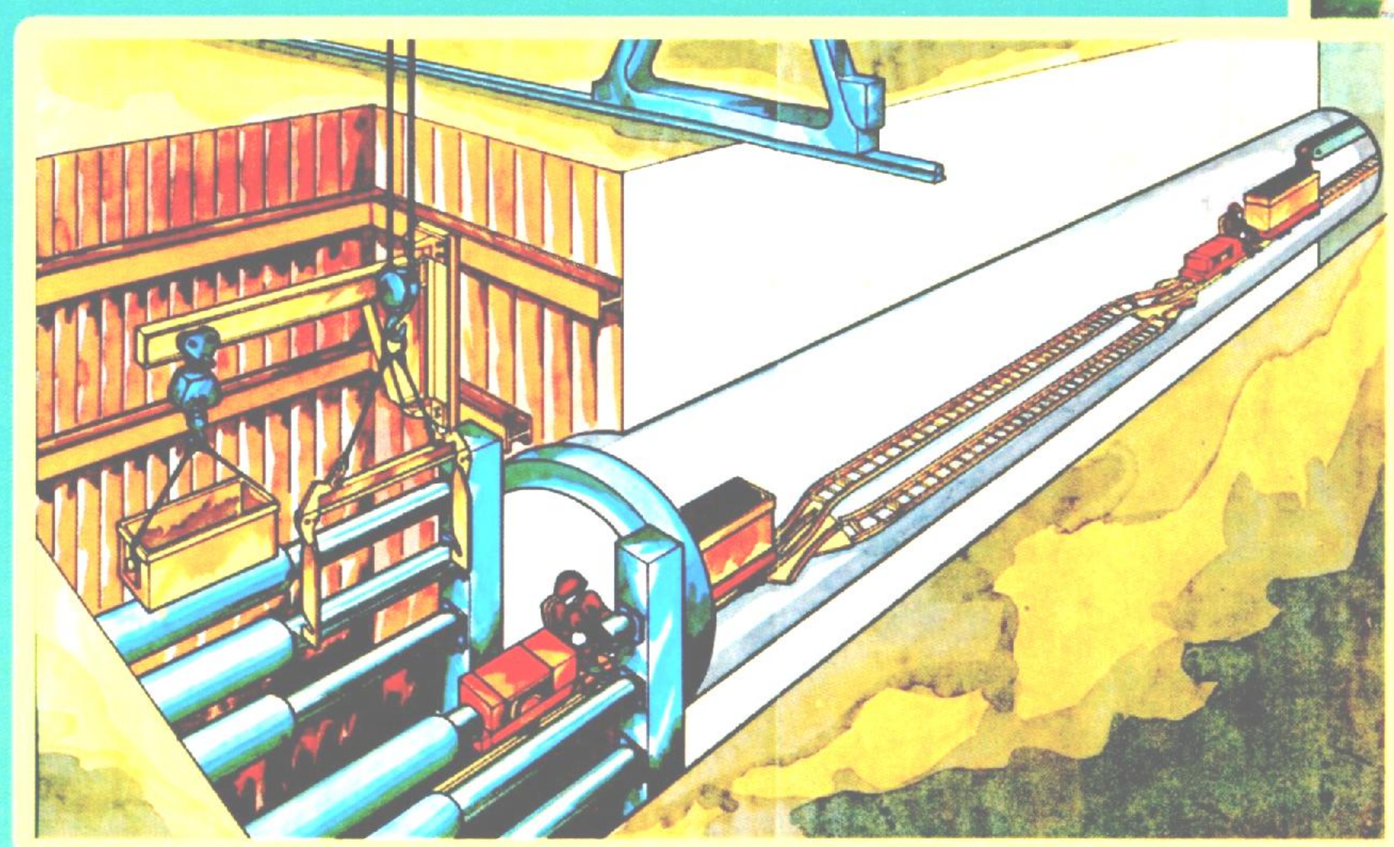
INTEGRATED INTERNATIONAL SYMPOSIUM
INTEGRISANI MEĐUNARODNI SIMPOZIJUM

TIORIR '11



PROCEEDINGS
ZBORNIK RADOVA

Volume 1, Knjiga 1

8th International Symposium Mine Haulage and Hoisting ISTI '11
VIII Međunarodni simpozijum Transport i izvoz ISTI '11

International Symposium
Sustainable Development of Mining and Energy Industry ORRE '11
Međunarodni simpozijum
Održivi razvoj rudarstva i energetike ORRE 11

Zlatibor,
September 11 – 15, 2011.

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Knjiga I / *Volume 1*

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International Symposium Sustainable Development of Mining and Energy Industry ORRE '11

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NEW APPROACH IN DESIGN OF AN INTERNAL OVERBURDEN DUMP IN BUCIM OPEN PIT IN FUNCTION ON MINIMAL COST OF TRANSPORT

NOV PRISTUP U DIZAJNIRANJU UNUTRAŠNJEG ODLAGALIŠTA POVRŠINSKOG KOPA BUČIM U FUNKCIJI MINIMALNIH TROŠKOVA TRANSPORTA

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Abstract: *With the deepening of the open pit, the transport distances for the sterile mass and the ore increased. This paper deals with the formation of an internal waste dump within the boundaries of the open pit in function on minimal cost of transport. The development of such waste dump should be in function of the space for disposing the waste according to existing situation on the field and the space for dumping. The internal waste dump will be use for permanent dumping and waste storage. Modern methods will be use to assess the slopes stability of the dump - method of lamellas, the method of Bishop, the method of Spencer and Janbu.*

Key words: *internal overburden dump, transport, overburden, slope stability, open pit*

Abstrakt: *Sa produbljavanju površinskog kopa, transportne distance za transport jalovine I rude se uvećavaju. Ovaj rad daje informacije za formiranje unutrašnjeg odlagališta u granici površinskog kopa u funkcii minimalnih troškova za transport. Razvoj odlagališta treba da bude u funkcii prostora za odlaganje u skladi sa postojnom situaciju na terenu za odlaganje. Unutrašnje odlagalište biće iskorišćeno za permanetno odlaganje jalovog materijala. Savremene metode: metoda lamela, metoda Bishop, metoda Specner i Janbu bice koriscene za procenu stabilnosti kosina unutrašnjeg odlagališta.*

Klučne reči: *unutrašnje odlagalište, transport, jalovina, stabilnost kosina, površinski kop*

1. INTRODUCTION

Research subject of this paper is to form the internal dump in the southern part of the open pit "Buchim" in the function of minimal transportation costs. Inner dump will be used for permanent storage and disposal of slag from the primary exploitation of the remaining amounts of deepening the Central ore body (CRT), the expansion in the northeastern part and quantities of future opencast "Vrshnik".

In other words, basic goal is forming of inner dump in the function of defining all main technical factors connected with the exploitation, transport and disposal of the sterile mas from the mine "Buchim" and quantities from the future open pit "Vrsnik".

Based on the subject and the purposes of research, and based on experiences from the contemporary world research methodology, the basic methodology of the research in this study used modern methods of design of internal dumps with discontinued disposal. In addition, as the basis for the formation of the slopes will be observed geotechnical characteristics of the working environment (substrate) and sterile mass. For this are applied modern methods to assess the slopes stability of bank disposal - method of lamellas, the method of Bishop, the method of Spencer and the method of Janbu.

2. FORMING OF THE INTERNAL DUMP

Based on the required space for the disposal of sterile mass from the exploitation in the open pit "Buchim", the available equipment for work, and adopted slope angles of the final slopes and in accordance with technical requirements, it is necessary to construct interior dump for about 18 million tons of solid matter in the next two years, with an annual capacity of 10 million tons of slag, with minimal costs of transportation and disposal. Generally, the disposal will create 2 (two) deep benches: 555 and 630. The formation of these benches will create another two temporary benches 480 and 600. The base of the dump is horizontal with an altitude of 450 m and consists of solid rocks - andesite and gneisses.

3. LOADING OF THE STERILE MASS

The process of loading is provided by the existing machines, or using:

- hydraulic front shovel with height shovel O&K RH 90C with a volume of 8 m^3, 1 piece,
- front shovel PH 1900 AL 7.65 with a volume of the shovel of 7.65 m^3, 2 pieces,
- front shovel PH BL 2100 with a volume of the shovel of 11.46 m^3, 1 piece.

The calculation is obtained for:

Table 1

No.	Shovel	Effective hour capacity [t/h]	Number of effective hours in the year	Effective annual capacity [t/year]
1	O&K RH 90C	869	4270	3710630
2	PH 1900 AL	738	4270	3151260
3	PH 2100 BL	1106	4270	4722620

Total capacity of all shovels is about 14.74 millions of tons. Given that annual is planned 10 million tons of slag, then they can fully meet the capacity and to reserve at least 4.74 million tons for the excavation of ore. In addition to these facilities with outside contractors, would significantly increase the capacity for both excavation of ore and for excavation of slag.

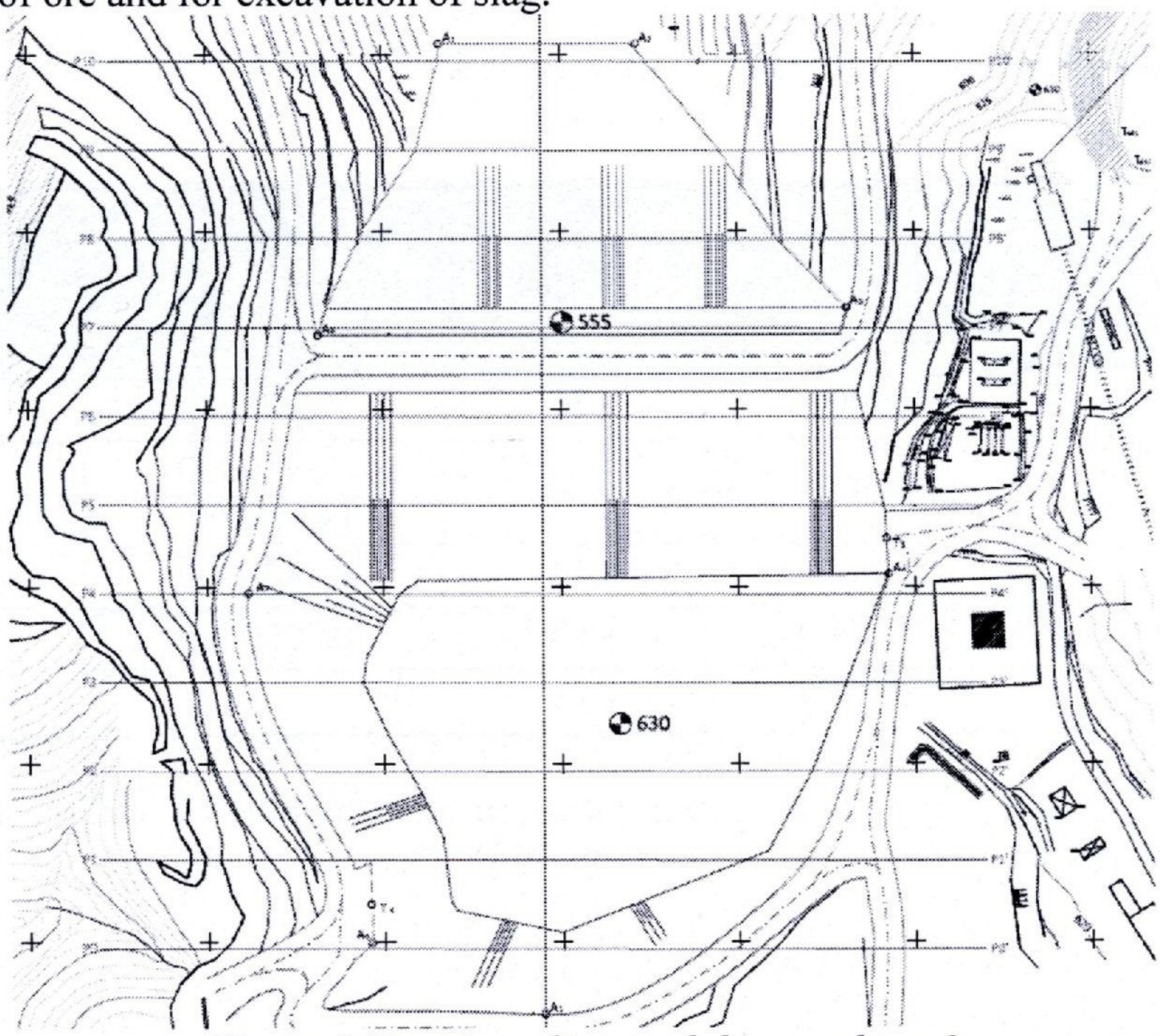
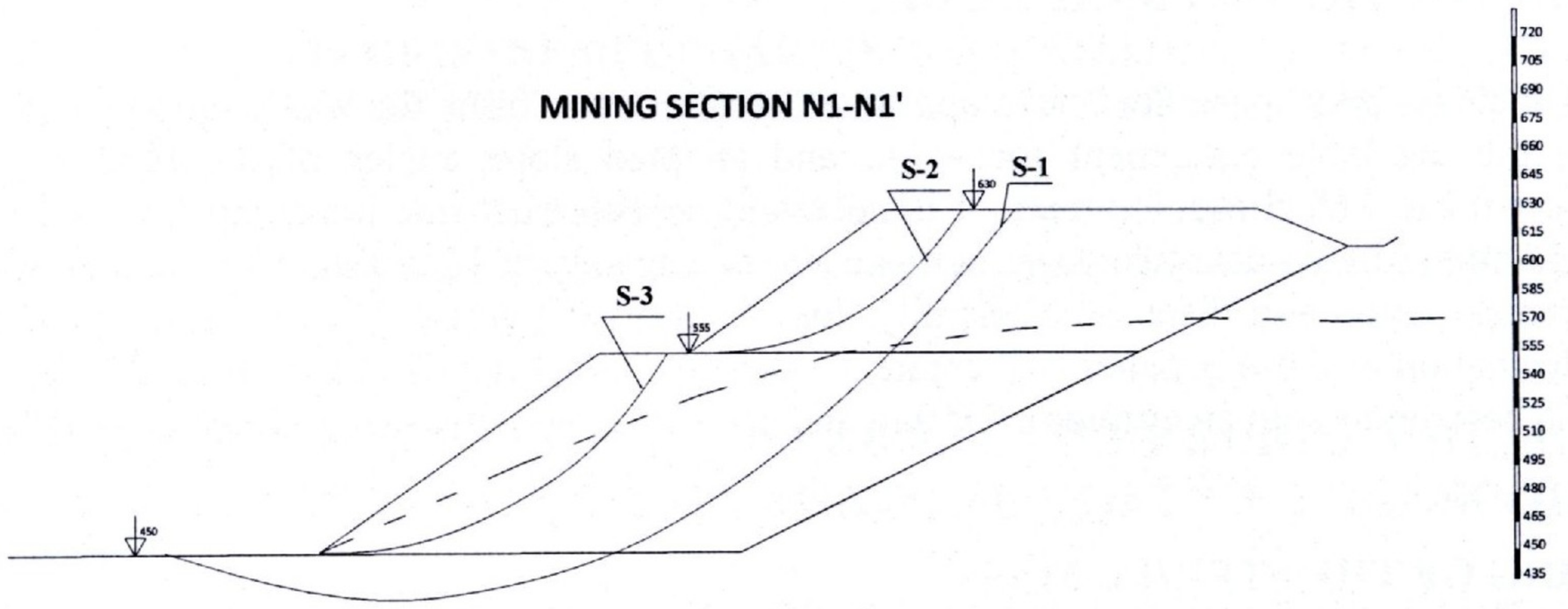


Figure 1 Forming of internal dump - phase 3



Minimal Value of Factor of Stability							Minimal Value of Factor of Stability						
Proposed slice surfaces and level of underground water (Ru=0.2)	S-1		S-2		S-3		Proposed slice surfaces (Ru = 0)	S-1		S-2		S-3	
	İ	F	İ	F	İ	F		İ	F	İ	F	İ	F
Ordinary	1.561		1.394		1.303		Ordinary	1.717		1.494		1.473	
Bishop	1.733		1.506		1.412		Bishop	1.891		1.596		1.655	
Janbu		1.557		1.393		1.306	Janbu		1.694		1.493		1.484
Spencer	1.742	1.747	1.505	1.508	1.416	1.417	Spencer	1.895	1.900	1.505	1.508	1.649	1.645

Figure 2 Longitudinal mining profile N1-N1'

4. FORMATION OF INNER DISPOSAL AS A FUNCTION OF MINIMIZING THE TRANSPORTATION COSTS FOR THE STERILE MASS

For transportation are provided the following mine trucks - dumpers:

- mine trucks - dumper TEREX TR 100, with technical load of 91 tons, 4 pieces
- mine trucks - dumper WABCO 120D, with technical load of about 109 tons, 2 pieces
- mine trucks - dumper WABCO 510E, with technical load of about 136 tons, 3 pieces
- mine trucks - CAT 785B with technical load of about 136 tons, 3 pieces.

Average length of the transportation roads is given in the Table 2.

Table 2

No.	Ore body	Planned amount for disposal in the internal dump [t]	Average distance [km]	Planned amounts for transport by uphill / downhill	Maximal angle of transportation
1	Central ore body	3269000	2.35	↑3269000	+7.5%
2	Expanding of CRT - northeast	19965000	1.5	↓13419000 ↑6546000	-7.5% +7.5%
3	Vrshnik	11800000	1.15	↓11800000	-7.5%
4	Bunardzik	17000000	1.98	↓17000000	-7.5%
5	Total	52369000	1.63		

According the Table 2, planned quantities for transportation along uphill - downhill, as well as the average distances to the new internal dump are selected to fulfill the basic conditions:

- achieve the planned capacity for disposal
- minimal length and
- maximal transportation angle of +7.5%.

If we take the data from the previous table, useful loads of dumpers will be:

Table 3

Dump trucks			Shovels			
			O&K RH 90C	PH 1900 AL	PH 2100 BL	Average
			t	t	t	t
			12.87	12.31	18.44	
TEREX TR 100	t	91	90.1	86.2	73.8	83.3
WABCO 120D	t	109	103.0	98.5	92.2	97.9
WABCO 510E	t	136	128.7	135.4	129.1	131.1
CAT 785B	t	136	128.7	135.4	129.1	131.1

Percentage utilization of loading and transport according to the system shovel - dumper is given in the following table.

Table 4

Dump trucks			Shovels		
			O&K RH 90C	PH 1900 AL	PH 2100 BL
			t	t	t
			12.87	12.31	18.44
TEREX TR 100	t	91	99.01 %	94.68 %	81.05 %
WABCO 120D	t	109	94.47 %	90.34 %	84.58 %
WABCO 510E	t	109	94.64 %	99.55 %	94.90 %
CAT 785B	t	136	94.64 %	99.55 %	94.90 %

Form the Table 4 could be seen the optimal utilization of the system shovel - dumper. For example, optimal combination of loading of the dumpers of the type TEREX TR 100 is with the shovel O&K RH 90C, and the dumpers of the type WABCO 120D and WABCO 510E is with the shovels PH 1900 AL.

Estimated time for one dumper cycle will be:

Table 5

No.	Ore body	Average distance [km]	Time of movement of filled trucks [h]	Time of movement of empty trucks [h]	Time of dumper cycle [h]
1	Central ore body	2.35	0.13	0.20	0.43
2	Expanding of CRT - northeast	1.5	0.08	0.13	0.32
3	Vrshnik	1.15	0.06	0.10	0.27
4	Bunardzik	1.98	0.11	0.17	0.38
5	Total	1.63	0.09	0.14	0.33

The estimated capacity for the transport of sterile mass from ore bodies and the various operational fields by trucks is given in the following table.

Table 6

No.	Ore body	Time of dump truck cycle [h]	TEREX TR 100 t/h	WABCO 120D t/h	WABCO 510E t/h	CAT 78 5B t/h
1	Central ore body	0.43	155.05	182.10	243.83	243.83
2	Expanding of CRT - northeast	0.32	208.34	244.69	327.64	327.64
3	Vrshnik	0.27	246.92	290.00	388.32	388.32
4	Bunardzik	0.38	175.45	206.06	*275.91*	275.91
5	Average	0.33	202.03	237.28	317.72	317.72

According to this, necessary number of dumpers for disposal in the internal dump will be:

Table 7

No.	Characteristic		TEREX TR 100	WABCO 120D	WABCO 510E	CAT 785B
1	Available number of dump trucks		4	2	3	3
2	Planned number of dump trucks		3	1	3	2
3	Planned annual capacity for dump truck	$x10^6$ t/year	2.59	1.01	4.07	2.71
4	Planned annual capacity for sterile mass transportation	$x10^6$ t/ year	10			
5	Effective annual capacity for transportation of sterile mass	$x10^6$ t/ year	10.38			
6	Reserve capacity for transportation of sterile mass	%	3			
7	Optimal number of dump trucks		3	1	3	2

5. DISSCUSION

Based on the results from this research, it can be concluded that the choice of the internal dump in the mine "Buchim" is good strategic decision. Namely, formation of dump with minimal cost of transport from one side, and stabilize the slopes of the open pit with disposal in the unearthed area, on the other side is real and rational solution. Besides this, recultivation will improve the spatial arrangement of the wider environment, and technical rehabilitation process would be simpler.

Choosing the optimal ratio shovel - dumper further enhances the advantages of this dump in relation to the existing - dump no. 1, dump northeast and dump east.

Further development of the open pit, with full excavation of the northeastern part of the ore body "Buchim" and its final deepening, will create area for future disposal and storage of the total sterile mass from the neighboring pits "Vrshnik" and "Bunardzik".

6. CONCLUSION AND PROPOSAL FOR FURTHER RESEARCH

Forming of the internal dump was made with multi - criteria approach, with optimization according the planned capacity, minimal transportation costs, allowed uphills for transportation roads and required amount for disposal.

Greatest importance is given to the minimize transportation costs or optimizing the use of shovels and dumpers. For this purpose, in the paper is presented an approach to optimize the work of the system shovel - dumper. Namely, based on Table 4 can ascertain the optimal choices shovel - dumpers with maximum utilization.

This research implies the need for analyzing the new equipment before purchase, or determining the need for purchase of equipment for transport and loading. This means that when purchasing new equipment is not only important unification of the same, but should be taken in consideration the analysis of the utilization. Namely, according to this analysis it could be seen that the shovel PH 2100 AL is not optimally used in conjunction with any of the 4 analyzed types of trucks. That means either purchasing a new shovel (within the technical characteristics of the shovel) or purchase another type of trucks (with varying technical capacity).

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