THE OPTIMAL PARAMETERS DETERMINATION OF DRILLING IN THE KOSOVO MOTORWAY PROJECT IN BELLANICA

Frashër Brahimaj[1], Risto Dambov[2], Abedin Brahimaj[3]
[1]University "Goce Delcev", FNTS, Stip, Macedonia, fibi232@hotmail.com
[2]University "Goce Delcev", FNTS, Stip, Macedonia, risto.dambov@ugd.edu.mk
[3]University of Mitrovica "Isa Boletini", FG, Mitrovica, Kosovo, a.brahimaj@hotmail.com

ABSTRACT
Drilling geometry parameters are of great importance when performing highway construction work, because this directly affects the volume of work to be performed and at the time of performing these works. The right determination of the drilling parameters will reduce the specific charge of explosive and increase the mined volume for drilling length. With the determination of drilling angle, it has been achieved to decrease the specific charge of explosive from 0.59 kg/m^3 to 0.49 kg/m^3 and to increase the mined volume for drilling length from 6.533 m^3/m to 7.467 m^3/m.
Keywords: *Blasting, specific charge, angle, volume, drilling.*

Introduction

In cases when the road passes to strong and hilly terrain, then we are obliged to open them with the help of the blasts, because it is impossible to dig them, as a result of the hardness of the material that builds that hilly part of the road.

Based on what has been mentioned above, it becomes the limitation of the slopes of the track, determination the height of benches, the determination of the width of the benches for safety, the angle of the benches, determination the transport routes and the safety factor of the slope. The opening of the track is done with the aid of cutting trenches, dividing the track according to the designed height of the benches.

The cutting trenches start at the highest point of the terrain through which the track passes, continuing towards to the track level.

In this paper, will be elaborated the shortcomings of the variant when drilling is at angle 63^0, according to the project design and advantages of the other variant when the drilling is at angle 90^0, based on other drilling parameters such as: drilling diameter, drilling geometry, depth of drilling, making the schemes of drilling nets, length of charging, stemming length and type of explosive.

The purpose of the paper is to treating these problems as mentioned above, to achieve good results during the blasting and to reduce the cost of blasting.

Determination of drilling parameters

Determination of the drilling parameters is done in order to have a better breaking of the rock, maintaining the stability of the slope and not affecting the surrounding objects.

Since we know that the European Standards for road construction are that the pieces of rocks do not exceed the size 500 [mm], this applies to place the material on the roadside base. In according on this are calculated all parameters of production drillings and are adopt like below.

The calculations of drilling parameters

The diameter of drilling calculated based on the diameter of pieces "D_p, and on the proportionality coefficient (k), the value of this is k = 0.1.

$$d_d = k \square D_p \quad (1)$$

The burden is calculated based on the equation:

$$W = 53 \cdot k_t \cdot d_d \cdot \sqrt{\frac{\Delta}{\gamma}} \quad (2)$$

Where are:
k_t - the coefficient that takes into account the state of the massive (cracks) and the energy losses due to them
d_d – the drilling diameter
Δ – the density of explosive
γ – the volumetric weight

The distance between holes in the row is calculated based on the coefficient of oncoming of the drillings (a = 0.75 ÷ 1.5), and to the burden (W), by the equation:

$$a = m \square W \quad (3)$$

The distance between rows is calculated based on the burden:

$$b = (0.85 \div 1) \square W \quad (4)$$

The stemming length is calculated based on the distance between rows (b), by the equation:

$$l_s = (0.8 \div 1.2) \cdot b \quad (5)$$

The length of sub drilling is calculated based on Langefors equation:

$$l_{sd} = (0.1 \div 0.3) \cdot W \quad (6)$$

The length of the drilling is calculated based on the equation:

$$l_{cd} = \frac{h + l_{sd3}}{\sin\beta} \quad (7)$$

Blasting field plan Variant I

The blasting field is in the form of a rectangle with following dimensions: length of the field is L = 56 m, the width L_t = 14 m, and the height is h = 10 m.

The said field has five drilling rows, with 20 holes in the row. The field in this exploitation place has in total 100 drillings with the 12 meters depths. The burden is appropriated W = 2.80 m, the distance between rows is appropriated b = 2.80 m, the distance between drillings in the row is appropriated a = 2.80 m, the angle of drillings is appropriated $\beta = 63^0$, based on the project, and drilling diameter is appropriated d_d = 89 mm.

For this case is prepared the schematic presentation of the field with drillings, and in this are presented surface parameters of the drillings, they can show in Figure 1. Also is prepared the profile of field with drillings and are presented drilling parameters, they can show in Figure 2, below.

For this filed below in Table 1. are presented calculations with software MS Excel, for:

1. Total length of drilling
2. Quantity of explosive
3. Blasted volume
4. Specific charge and
5. Blasted volume from one meter of drilling

Table 1: Detonation specifications for exploitation place in Bellanica

Project	"Kosovo Motorway Project"							
Region – Municipality	Prizren - Malishevë							
Detonating company	"Jaha Company"							
Date of blasting	20/03/2012							
Naming	Symbol						**Total**	Unit
Row		**R.1**	**R.2**	**R.3**	**R.4**	**R.5**		
Total drilling length	L_d	240	240	240	240	240	1200	m'
Number of holes	n_d	20	20	20	20	20	100	holes
Distance between holes	a	2.8	2.8	2.8	2.8	2.8		m'
Distance between rows	b	2.8	2.8	2.8	2.8	2.8		m'
Hole diameter	d_d	89	89	89	89	89		mm
Drilling angle	α,β	63	63	63	63	63		^{0}
Stemming	l_s	2.8	2.8	2.8	2.8	2.8	280	m'
Cartridge diameter	d_c	89	89	89	89	89		mm
Cartridge length	l_c	50.00	50.00	50.00	50.00	50.00		cm
Compression	C	4%	4%	4%	4%	4%		%
Explosive density	Δ	0.85	0.85	0.85	0.85	0.85		g/cm^3
Effective diameter of compression	d^1	90.835	90.835	90.835	90.835	90.835		mm
Effective length of compression	l^1	48	48	48	48	48		cm
Drilling length	l_d	12	12	12	12	12		m'
Volume of rock per hole	V_h	83.802	83.802	83.802	83.802	83.802		m^3
Average rock height	h	10.689	10.689	10.689	10.689	10.689		m'
Cartridge mass	q_s	2.643	2.643	2.643	2.643	2.643		kg
Calculated number of cartridges in hole	n_c	19.17	19.17	19.17	19.17	19.17		pcs.
Estimated number of cartridges	n_{ec}	19	19	19	19	19		pcs.
Filling length	l_{ch}	9.20	9.20	9.20	9.20	9.20	920	m'
Hole filling in m'	Q_m	5.51	5.51	5.51	5.51	5.51		kg/m
Filling of a hole	Q_h	50.65	50.65	50.65	50.65	50.65		kg
Specific consumption of EXP.	q_{sch}	0.60	0.60	0.60	0.60	0.60	0.60	kg/m^3
Total filling amount with EXP.	Q	1013.013	1013.013	1013.013	1013.013	1013.013	5065.1	kg
Measure the volume of obtained	V	1676.04	1676.04	1676.04	1676.04	1676.04	8380.2	m^3
Volume from one meter drilling	V_{md}	6.98	6.98	6.98	6.98	6.98	6.98	m^3/m

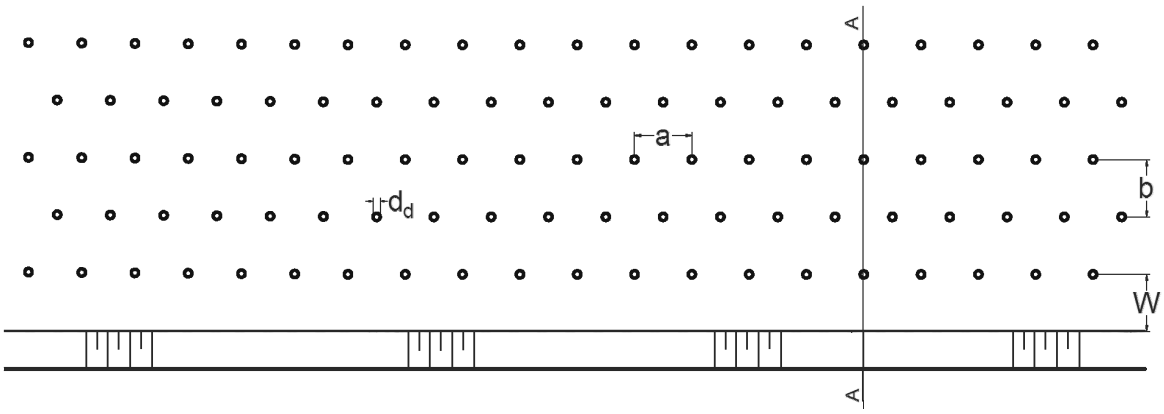

Figure 1: The schematic pattern of drillings

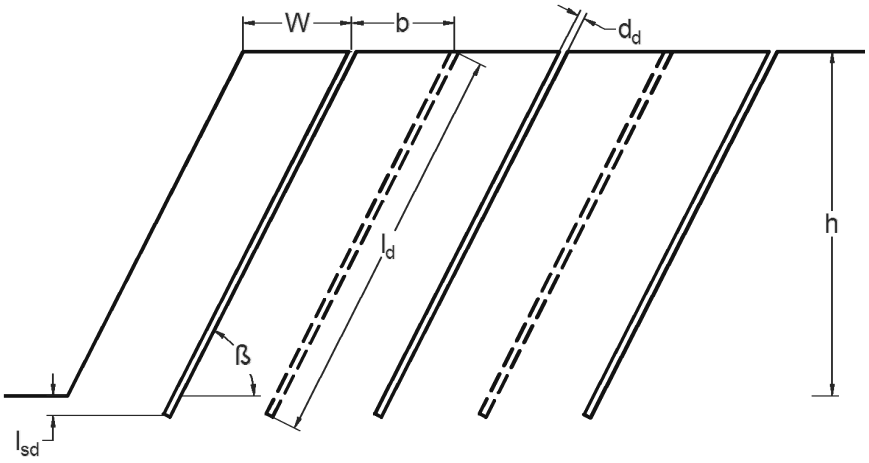

Figure 2: The profile A - A

Blasting field plan Variant II

The blasting field is in the form of a rectangle with following dimensions: length of the field is L = 56 m, the width L_t = 14 m, and the height is h = 10 m.

The said field has five drilling rows, with 20 holes in the row. The field in this exploitation place has in total 100 drillings with the 10.5 meters depths. The burden is appropriated W = 2.80 m, the distance between rows is appropriated b = 2.80 m, the distance between drillings in the row is appropriated a = 2.80 m, the angle of drillings is appropriated $\beta = 90^0$, and drilling diameter is appropriated d_d = 89 mm.

For this case is prepared the schematic presentation of the field with drillings, and in this are presented surface parameters of the drillings, they can show in Figure 3. Also is prepared the profile of field with drillings and are presented drilling parameters, they can show in Figure 4, below.

For this filed below in Table 2. are presented calculations with software MS Excel, for:

1. Total length of drilling
2. Quantity of explosive
3. Blasted volume
4. Specific charge and
5. Blasted volume from one meter of drilling

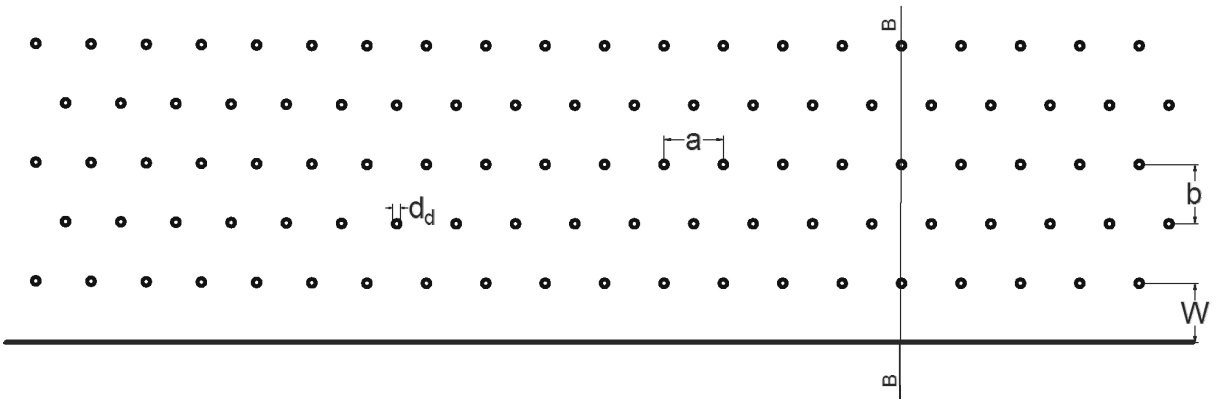

Figure 3: The schematic pattern of drillings

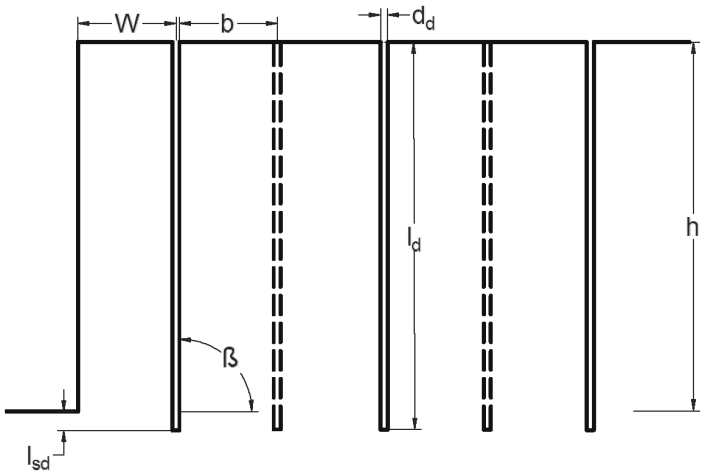

Figure 4: The profile B - B

Table 1: Detonation specifications for exploitation place in Bellanica

Project	"Kosovo Motorway Project"							
Region – Municipality	Prizren - Malishevë							
Detonating company	"Jaha Company"							
Date of detonation	04/04/2012							
Naming	Symbol						**Total**	Unit
Row		**R.1**	**R.2**	**R.3**	**R.4**	**R.5**		
Total drilling length	L_d	240	240	240	240	240	1200	m'
Number of holes	n_d	20	20	20	20	20	100	holes
Distance between holes	a	2.8	2.8	2.8	2.8	2.8		m'
Distance between rows	b	2.8	2.8	2.8	2.8	2.8		m'
Hole diameter	d_d	89	89	89	89	89		mm
Drilling angle	α,β	90	90	90	90	90		^{0}
Stemming	l_s	2.8	2.8	2.8	2.8	2.8	280	m'
Cartridge diameter	d_c	89	89	89	89	89		mm
Cartridge length	l_c	50.00	50.00	50.00	50.00	50.00		cm
Compression	C	4%	4%	4%	4%	4%		%
Explosive density	Δ	0.85	0.85	0.85	0.85	0.85		g/cm^3
Effective diameter of compression	d^1	90.835	90.835	90.835	90.835	90.835		mm
Effective length of compression	l^1	48	48	48	48	48		cm
Drilling length	l_d	12	12	12	12	12		m'
Volume of rock per hole	V_h	94.080	94.080	94.080	94.080	94.080		m^3
Average rock height	h	12.000	12.000	12.000	12.000	12.000		m'
Cartridge mass	q_s	2.643	2.643	2.643	2.643	2.643		kg
Calculated number of cartridges in hole	n_c	19.17	19.17	19.17	19.17	19.17		pcs.
Estimated number of cartridges	n_{ec}	19	19	19	19	19		pcs.
Filling length	l_{ch}	9.20	9.20	9.20	9.20	9.20	920	m'
Hole filling in m'	Q_m	5.51	5.51	5.51	5.51	5.51		kg/m
Filling of a hole	Q_h	50.65	50.65	50.65	50.65	50.65		kg
Specific consumption of EXP.	q_{sch}	0.54	0.54	0.54	0.54	0.54	0.54	kg/m^3
Total filling amount with EXP.	Q	1013.013	1013.013	1013.013	1013.013	1013.013	5065.1	kg
Measure the volume of obtained	V	1881.60	1881.60	1881.60	1881.60	1881.60	9408.0	m^3
Volume from one meter drilling	V_{md}	7.84	7.84	7.84	7.84	7.84	7.84	m^3/m

The Variant II shown in Figure 4, can only be used when the rock excavating be in the middle of the highway track axis to a distance of 12 ÷ 15 m from the bench line that is foreseen to be left on the slope. The remaining part of the rock of 12 ÷ 15 m, when using Variant II, should be blasting by the method shown in Figure 5, also using contour drillings.

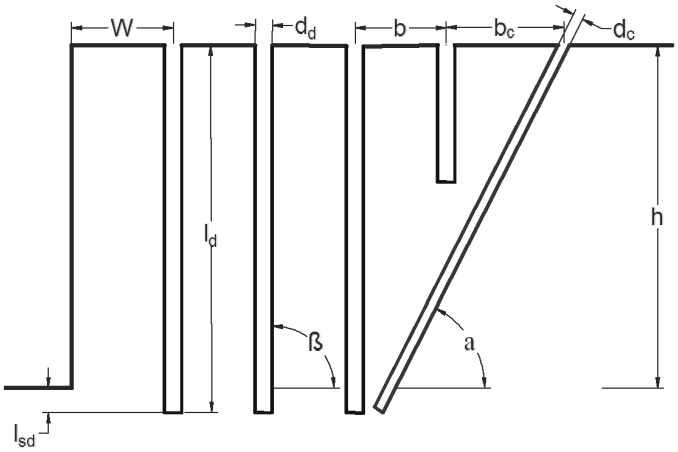

Figure 5: The method of forming the bench with Variant II

Results

At the beginning, the Variant I of drillings is applied when the product drills are parallel to the contour drills, and then it is passed to the Variant II of drillings, when the product drills are 900 while the contour drills at the angle of projected bench.

By applying Variant II is reached to have the specific charge of explosive much smaller compared to Variant I, based on the calculations made in Table 1 and Table 2. That results are presented on Figure 6.

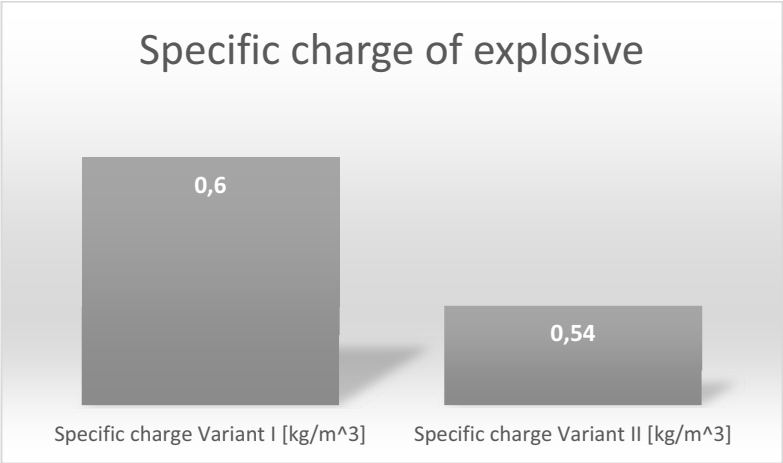

Figure 6: Specific charge values of the explosive depending on drilling variants

Also with the application of Variant II it has been achieved to have a larger volume of blasted mass for 1 m of drilling length. Where on this occasion it has been achieved that the opening of the trench is performed with smaller expense, compared to Variant I. These results are presented in Figure 7.

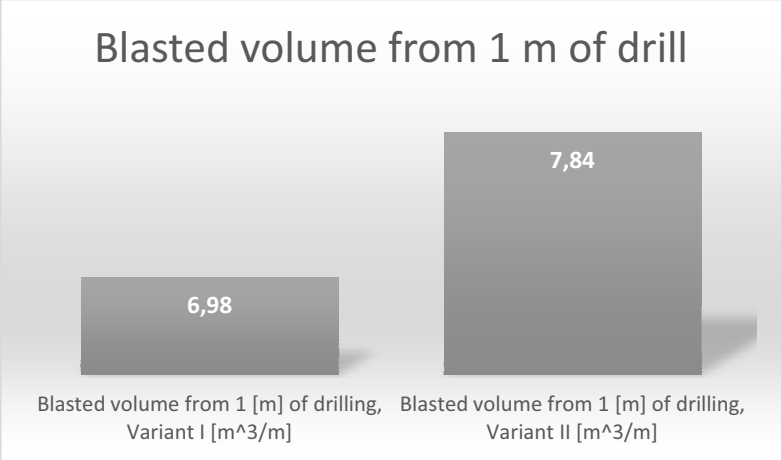

Figure 7: Blasted volume from 1 m of drill, depending on drilling variants

Conclusion

To build road infrastructure it is imperative to have professional knowledge in the implementation of road projects, the use of explosive, on initiation systems of explosives and the selection of drilling equipment.

From what has been elaborated above, it is seen that at the beginning of the drilling and blasting process in Bellanica, the Variant I was used to carry out the blasts, and later it was passed to Variant II.

The disadvantages of Variant I, are: greater volume of drilling and blasting works, greater consumption of explosives and initiating means, greater time for project completion and lower utilization of drilling length. The advantages of Variant I, are: keeping the designed angle of the bench even during the works and lower risk of demolition of the bench.

The disadvantages of Variant II, are: lower stability of the bench and not keeping the projected bench angle during the drilling and blasting works. While the advantages of Variant II, are: less consumption of the explosives and initiating means, less volume of drilling and blasting works, less time to complete the project and greater use of drilling length.

Looking at the disadvantages and advantages of each method, it turns out that Variant II it is more reasonable to use, because it is more economical and enables project completion for a shorter time.

References

1. Brahimaj, I. Brahimaj, F. (2019). The massive and special blasting's, Mitrovica.
2. Brahimaj, I. Brahimaj, F. Brahimaj, S. (2016). Drilling & Blasting Optimal Parameters and the Results in the Dismemberment of Limestone in Volljak, Journal of International Environmental Application & Science, vol. 11, no. 1, pp 87-91
3. Brahimaj, I. (2012). Contribution in optimal parameters selected for the massive blasting's in limestone of Gremnik, PhD thesis, Mitrovica.
4. Brahimaj, F. (2013). The application of contour blasting's in the road infrastructure Morine – Merdare, Master thesis, Mitrovica.
5. Brahimaj, SH. (2013) Opening and Preparation of trenches on the highway Morinë – Merdare, Master thesis, Mitrovica.
6. Дамбов, Р. (2011). Методи на минирање, Штип.
7. Дамбов, Р. (2012). Дупчење и минирање, Штип.

PROCEEDINGS

OF THE XV INTERNATIONAL CONFERENCE OF THE OPEN AND UNDERWATER MINING OF MINERALS

June 3-7, 2019
Varna, Bulgaria

SCIENTIFIC AND TECHNICAL UNION OF MINING, GEOLOGY AND METALLURGY
ISSN 2535-0854

General Sponsor:

ellatzite med AD

Sponsors:

ASAREL MEDET JSC

GEOSTROY AD

GEOTECHMIN ГЕОТЕХМИН

GEOTRADING

ЕНЕРГИЙНА НЕЗАВИСИМОСТ И НАЦИОНАЛНА СИГУРНОСТ

МИНИ МАРИЦА-ИЗТОК ЕАД

Organizing committee

Chairman:

Prof. DSc Eng. Tzolo Voutov	Honorary chairman, Scientific and technical union of mining, geology and metallurgy

Honorary Chairman:

Prof. DSc Stoyan Hristov	University of mining and geology "St. Ivan Rilski"

Deputy Chairmen:

Prof. DSc Eng. Nikolay Valkanov	Chairman, Bulgarian chamber of mining and geology
Prof. Dr. Lyuben Totev	Rector, University of mining and geology "St. Ivan Rilski"
MSc. Eng. Andon Andonov	General manager, Maritza Iztok Mines JSC

Scientific secretaries:

Dr. Eng. Kremena Dedelyanova	Chairman, Scientific and technical union of mining, geology and
Dr. Eng. Konstantin Georgiev	Honorary member of the ISM

Coordinators:

Dr. Krassimira Arsova	Scientific and technical union of mining, geology and metallurgy
Dr. Julian Dimitrov	University of mining and geology "St. Ivan Rilski"

Members:

Assoc. Prof. Dr. Anatolii Angelov	University of mining and geology "St. Ivan Rilski"
Dr. Eng. Botyo Tabakov	"BT engineering" Ltd.
Prof. Dr. Valentin Velev	University of mining and geology "St. Ivan Rilski"
Dr. Eng. Vladimir Genevski	Scientific and technical union of mining, geology and metallurgy
Prof. Dr. Georgi Konstantinov	University of mining and geology "St. Ivan Rilski"
MSc. Eng. Dancho Todorov	"NIPRORUDA" JSC
MSc. Eng. Delcho Nikolov	"Assarel Medet" JSC
MSc. Eng. Dimitar Angelov	"Kaolin" JSC
Prof. Dr. Dimitar Anastasov	University of mining and geology "St. Ivan Rilski" - Branch Kardjali
Dimitar Tzotzorkov	"Assarel Medet" JSC
MSc. Eng. Dimitar Tzotzorkov	"Bulteh" Ltd.
MSc. Eng. Dimitar Cholakov	"Maritza Iztok Mines" JSC
Prof. DSc Dimcho Jossifov	Scientific and technical union of mining, geology and metallurgy
MSc. Eng. Dragomir Draganov	"Ellatzite-med" JSC
Prof. Dr. Ivaylo Koprev	University of mining and geology "St. Ivan Rilski"
MSc. Eng. Ivan Bogdanov	MDZ "Balsha" JSC
Dr. Eng. Ivan Mitev	Bulgarian chamber of mining and geology
Dr. Eng. Iliya Garkov	"Dundee Precious Metals Krumovgrad" EAD
Iliyan Rangelov	"Belaz-Sofia" Ltd.
Assoc. Prof. Kiril Chobanov	"Geotechmin" Ltd
MSc. Eng. Kostadin Naydenov	"Ellatzite-med" JSC
Dr. Eng. Krasimir Karparov	"Assarel Medet" JSC
Assoc. Prof. Dr. Nikola Dobrev	"KCM 2000" JSC
MSc. Eng. Nedelcho Bonev	"Minstroy holding" JSC
Prof. Dr. Pavel Pavlov	University of mining and geology "St. Ivan Rilski"
Prof. Dr. Petko Dimitrov	Institute of oceanology, Bulgarian academy of sciences
Radomir Cholakov	"Kaolin" JSC
Assoc. Prof. Dr. Stanislav Topalov	Association "Bulgarian coal mining"
MSc. Eng. Stoyo Bosnev	"MINPROEKT" JSC
Dr. Eng. Todor Tzonkov	"Andezit" Ltd
MSc. Eng. Shteryo Shterev	Scientific and technical union of mining, geology and metallurgy

International Scientific Committee

Prof. DSc Stoyan Hristov	- Bulgaria
Prof. Dr. Jani Bakallbashi	- Albania
Cor. member Viktor Prushak	- Belarus
Prof. Dr. Carsten Drebenstedt	- Germany
Prof. Dr. Risto Dambov	- Macedonia
Prof. Dr. Zoran Panov	- Macedonia
Prof. Dr. Zoran Despodov	- Macedonia
Prof. DSc Marek Cala	- Poland
Prof. Dr. Nicolae Ilias	- Romania
Prof. DSc Andrey Korchak	- Russia
Prof. DSc Sergey Kornilkov	- Russia
Prof. DSc Valeriy Suprun	- Russia
Prof. DSc Victor Gordeev	- Russia
Acad. Kliment Trubetskoy	- Russia
Prof. DSc Aleksandr Myaskov	- Russia
Assoc. Prof. Dr. Joze Kortnik	- Slovenia
Prof. Dr. Vladimir Pavlovich	- Serbia
Dr. Eng. Milan Stojakovic	- Serbia
Assoc. Prof. Dr. Tomislav Subaranovic	- Serbia
Prof. Dr. Reşat Ulusay	- Turkey
Prof. Dr. Turgay Onargan	- Turkey
Acad. Gennadii Pivnyak	- Ukraine
Dr. Eng. Vladimir Karpishek	- Czech republic

Thematic topics

A. Innovations in the construction and operation of opencast mines and quarries.
B. Modern technologies and facilities in underwater mining of minerals.
C. Drilling and blasting activities and safety techniques for open mining of minerals.
D. Drainage and stability and consolidation of the slopes in mines, quarries and waste dumps.
E. Quality management. Economic efficiency in open and underwater mining.
F. Protection and reclamation of environment during and after mining activities.
G. Information technologies in geological and mining activities.
H. Innovations in electrification, automation, mechanization and repair.
I. Advanced technologies in mineral processing and leaching.
J. Mining legislation. Qualification and specialization of the experts in open and underwater mining.