ЗРГИМ
Здружение на рударски и геолошки инженери на Р. Македонија

XI ТО СТРУЧНО СОВЕТУВАЊЕ НА ТЕМА:
Технологија на подземна и површинска експлоатација на минерални суровини
ПОДЕКС – ПОВЕКС '18
Струга
09 – 11. 11. 2018 год.

SEISMIC IMPACT FROM MASSIVE BLASTINGS ON AROUND OBJECTS

Risto Dambov[1], Frashër Brahimaj[1], Ejup Ljatifi[2], Ilija Dambov[3]
[1]University "Goce Delcev", Faculty of Natural and Technical Sciences, Shtip, R. Macedonia
[2]Ministry of Economy of R. Macedonia – Department of Mineral Resources, Skopje, R. Macedonia
[3]Mine for copper "Bucim", Radovis, R. Macedonia

Abstract: *The Company "GeoMineral" operates in Astrozub, which exploitation limestone for the needs of quarry and market. In this deposit, drilling is usually 15 [m] deep, where we get a field with 126 drillings of 15 [m] in length is considered. With the distance between the drillings in the row 3.5 [m], with the distance between rows of 3.5 [m] and the drilling diameter 89 [mm]. To perform the blasting, the ANFOKOS explosive with density 0.85 [g/cm^3] was taken. For initiation has been taken the Nonel system for initiated*
of drilling and surface initiation. Based on all the above, it emerges that the distance of uncertainty is up to 184 [m], while the houses are over 500 [m] away from the blasting field. Also and the vibrations result to be 2,508 [mm / s], which proves that the blasts at this site do not have any impact on the surrounding buildings, based on permissible seismic vibration rates.

Key words: Nonel system, blasting, drilling, seismic distance, safety distance

1. INTRODUCTION

With the economic growth of the country and the needs for construction of road infrastructure, sewerage, high construction, etc. The need for limestone has been increased at the country level, especially in the central part of Kosovo, where is located the mineral deposit and mine of limestone exploitation in Astrozub, which is exploiting by the company "GeoMineral". But this process of limestone exploitation in this region is not going through without complaints from citizens, who occasionally complain that they are shaking their homes even though their homes are more than 500 [m] away from the exploitation area and the place when blasting's are doing. For this reason, the calculations for seismic impact in the surrounding buildings will be made in order to determine whether it has any impact or no impact on the surrounding facilities. In order to be safer then we will take the distance of the possibility of impact less than it really is this distance between the blast and the surrounding houses, where all this will be discussed in the following, taken the example, the blast carried out earlier in this place.

2. DETONATION FIELD DESIGN

The field in this exploitation place has 126 drillings in total with depths 15 m. The line of least resistance was W = 3.5 m, distance between rows b = 3.5 m, distance between drillings in row a=3.5 m, drilling angle β=70^0 and drilling diameter d=89mm.

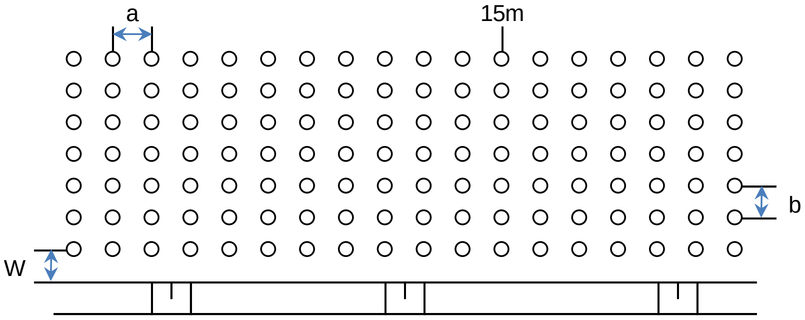

Figure 1. Detonation field plan

3. CALCULATION OF MATERIAL NEEDED FOR TO BLASTING

The calculation of the material needed for field detonation was made with MS Excel program which is provided in tabular form, where the required calculating equations were used in the Table 1.

Table 1. Detonation specifications for exploitation place in Astrozub.

Quarry		**"GeoMineral"**					
Region – Municipality		**Prizren – Malishevë**					
Detonating company		**"Jaha Company"**					
Date of detonation		**17.07.2018**					
						Total	
		G.1	**G.2**	**G.3**	**G.4**		
Total drilling length	m	450	450	450	540	1890	m'
Number of holes	N_b	30	30	30	36	126	hole
Distance between holes	a	3.5	3.5	3.5	3.5		m'
Distance between rows	b	3.5	3.5	3.5	3.5		m'
Hole diameter	Ø	89	89	89	89		mm
Drilling angle	α	70	70	70	70		^{0}
Cartridge diameter	d	89	89	89	89		mm
Explosive density	γ	0.85	0.85	0.85	0.85		g/cm^3
Effective diameter of compression	d^1	91.312	91.312	91.312	91.312		mm
Drilling length	L_{sh}	15	15	15	15		m'
Volume of rock per hole	V	172.630	172.630	172.630	172.630		m^3
Average rock height	H_{sh}	14.092	14.092	14.092	14.092		m'
Cartridge mass	q_s	1.744	1.744	1.744	1.744		kg
Calculated number of cartridges in hole		38.92	38.92	38.92	38.92		pcs.
Estimated number of cartridges		39	39	39	39		pcs.
Filling length		12.20	12.20	12.20	12.20		m'
Hole filling in m'		5.56	5.56	5.56	5.56		kg/m
Filling of a hole	q_{sh}	67.87	67.87	67.87	67.87		kg
Specific consumption of EXP.	q_{sp}	0.39	0.39	0.39	0.39	0.39	kg/m^3
Total filling amount with EXP.	Q_A	2036.226	2036.226	2036.226	2443.472	8552.2	kg
Measure the volume of obtained	V_A	5178.89	5178.89	5178.89	6214.66	21751.3	m^3

July, 2018

Specification of expenses for field detonation is:

ANFOKOS	8425 kg
Superpower 90 (F = 50 mm)	140 kg
Nonel Detonator U475 (L = 18 m)	126 pcs.
Nonel Connector 25 ms	18 pcs.
Nonel Connector 42 ms	108 pcs. + (2 spare pcs.)
Dynoline	300 + (300 m reserve)

4. FILLING OF DRILLINGS USING THE NONEL SYSTEM FOR INITATION

After the distribution of explosive and initiation material in the field, the filling process begins. At the bottom of the drilled hole the striking cartridge together with Nonel detonator is placed (U475 ms). The filling with ANFOKOS begins up to the tapping level.

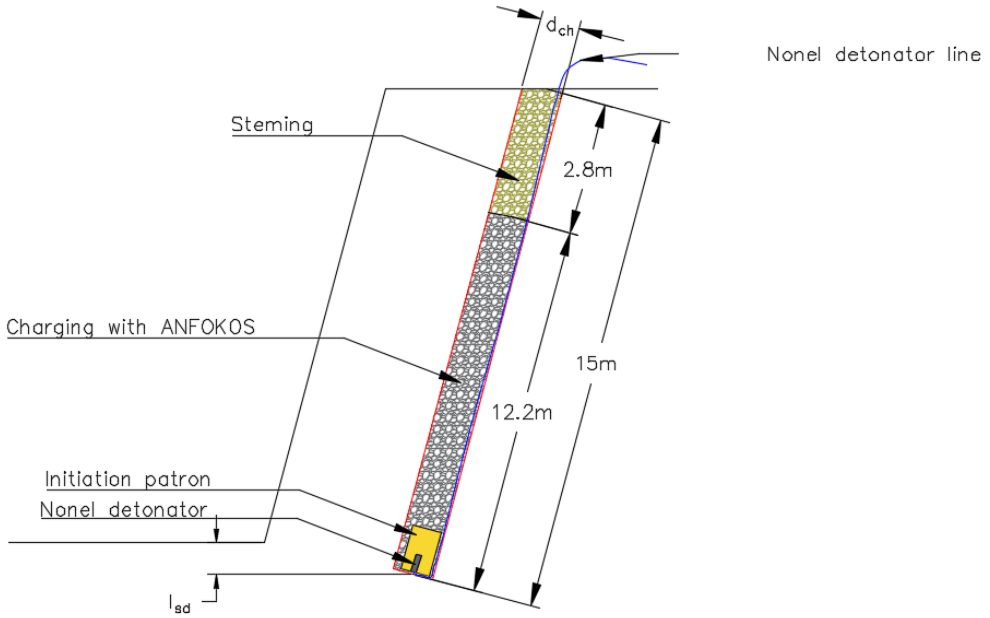

Figure 2. Schematic presentation of hole filling

4.1. Field connection with nonel system

In order to enable the safe initiation of the connection with Nonel system we should take into account the connection of Nonel detonators that are inserted in the hole with Nonel connectors that are always on surface and should closely follow the connection from one hole to the other and from one row to the other. After all these actions are undertaken in each drill and after all connectors are placed and connected in every drill, the field is considered to be connected.

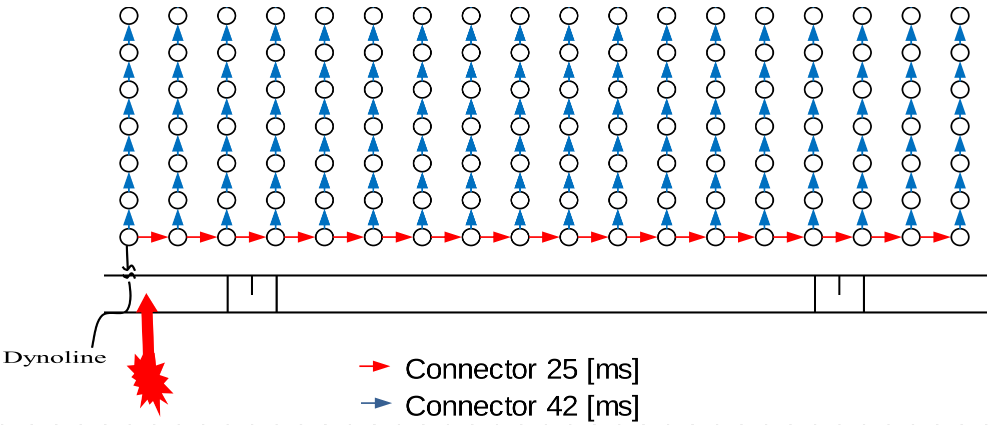

Figure 3. Schematic presentation of field connection with Nonel system

4.2. Calculation for safety distance

According to the seismic action of the explosive filling, the radius of the hazardous area for construction objects is calculated according to the formula:

$$D = K_s \cdot a \cdot \sqrt[3]{Q} \ \ [m]$$

Where are:
K_s – Proportionality coefficient depending on the type of rock that fall with blasting, (from Table 2.).
Q – Quantity of explosive filling, [kg]
a – Coefficient dependent on the blast action indicator (from Table 3.).

Table 2. Coefficient values (Ks)

Type of rock at the base of the object	K_s
Strong rocks without cracks - monolithic	3
Strong but cracked rocks	5
Land of gravel	7
Land of sands	8
Land of clay	9
Filling land	15
Holder water land	20

Table 3. Coefficient values (a)

Blasting conditions	a
Complete blast for n = 0,5	1,2
Blasting action indicator n = 1	1,0
Blasting action indicator n = 2	0,8
Blasting action indicator n = 3	0,7

$$D = 9 \cdot 1 \cdot \sqrt[3]{8565} = 184 \ [m]$$

According in this calculation the safety distance between the object and the blasting is more than 184 [m]. If the distance between them is less than 184 [m], isn't safety for object and is possible to have damage.

4.3. Calculation for seismic distance

For to calculate the seismic distance, is necessary to know the length of blastholes and the quantity of explosives per blasthole, also is necessary to know the initiation delays of the blastholes. It's necessary to know because according in this we can look how many kilograms of explosive are initiate in same time. These are shown on Figure 1 and Figure 3.

According on the Figure 3, we can based on this when the time of initiation of blastholes is changed between blastholes, and only one blasthole can blast in same time.

The maximum of explosive which initiate in one delay is shown on following calculation:

$$Q_{max} = \frac{\pi \cdot d_d^2}{4} \cdot (l_h - l_s) \cdot \Delta \cdot 1.05 = \frac{3.14 \cdot 0.089^2}{4} \cdot (15 - 2.8) \cdot 850 \cdot 1.05 = 67.70[kg]$$

Table 4. Calculating the velocity of vibrations: Radial, Transversal, Vertical and their resultant.

Elements of Peak Particle Velocity "v" [mm/s]	At the upper bench [mm/s]	At the bottom bench [mm/s]
Radial (longitudinal)	$v_r = 220.15 \cdot (DR)^{-1.55}$ $v_r = 220.15 \cdot (22.36)^{-1.55} = 1.782$	$v_r = 75.29 \cdot (DR)^{-1.23}$ $v_r = 75.29 \cdot (22.36)^{-1.23} = 1.648$
Transversal	$v_t = 195.23 \cdot (DR)^{-1.55}$ $v_t = 195.23 \cdot (22.36)^{-1.55} = 1.581$	$v_t = 60.60 \cdot (DR)^{-1.16}$ $v_t = 60.60 \cdot (22.36)^{-1.16} = 1.648$
Vertical	$v_v = 187.95 \cdot (DR)^{-1.55}$ $v_v = 187.95 \cdot (22.36)^{-1.55} = 1.522$	$v_v = 84.61 \cdot (DR)^{-1.33}$ $v_v = 84.61 \cdot (22.36)^{-1.33} = 1.357$
Vector amount (resultant)	$v_{vr} = 206.86 \cdot (DR)^{-1.42}$ $v_{vr} = 206.86 \cdot (22.36)^{-1.42} = 2.508$	

DR – wrinkled distance (waves) which is calculated according to the following equation

$$DR = \frac{D}{\sqrt{Q_{max}}} = \frac{184}{\sqrt{67.70}} = 22.36 \left[\frac{m}{\sqrt{kg}}\right]$$

Based on Table 5, this blasting is within the permissible norms, because the objects on this place are in distance more than 250 [m].

Table 5. Guideline values for vibration velocity to be used when evaluation the effects of short-term vibration on structures

Line	Type of structure	Guideline value for velocity (u_i), in mm/s			
		Vibration at the foundation at a frequency of			Vibration at horizontal plane of highest floor at all frequencies
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz*	
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20	15
3	Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g. listed buildings under preservation order)	3	3 to 8	8 to 10	8

* At frequencies above 100 Hz, the values given in this column may be used as minimum values.

5. CONCLUSION

The exploitation of minerals by the surface mining method with blasting in many cases does not pass without impact on the environment due to noise, dust and vibration. But that does not mean that it always has an impact on the environment because with the development of technology and the use of the Nonel system, noise and vibration have been greatly reduced. With the right application of the Nonel system we do not allow two drillings to ignite at the same time, then the noise and vibration will be so small that it will not affect the objects around mining. To make such connections to have as little vibration, we need to make combinations of surface slowdowns, using Nonel connectors with different slowdowns, to make the slowdown between the drillings in the row and between rows.
Very good results gives the combination of Nonel connectors by 25 [ms] slowdown with Nonel connectors by 42 [ms]. Where Nonel connectors by 25 [ms] slowdown should be set to make slowdown between drillings in the row, while Nonel connectors by 42 [ms] slowdown should be set to slower between rows. With this use of the Nonel system to make the connection of the initiation of charged drillings, it is achieved that the mined material is dumped in front of the bench, releasing sufficient space for subsequent drillings to make the dumped of the mined material. This free space formed by the delay of initiation between drilling prevents the explosion of the explosive for to causing vibration, because the force of explosion is only used for material breakage and an amount of this force passes into the air at the moment of the cracked on the massif which is blasting. The length of the stemming also plays an important role in causing the vibration, because if the stemming is too large then the forces of explosion can not pass to the air but will remain in the interior of the massif, causing vibration and tensions. To avoid these vibrations, the stemming should not be greater than the distance between rows.

REFERENCES

[1] Dambov R.,: Dupcenje i miniranje, Univerzitetski ucebnik, UGD- Stip, 2013
[2] Moore J. Adrian.; Richards B. Alan: Golden pick cut – back, fly rock control and calibration of e predictive model, Melbourne 2005
[3] Savić M.: Miniranje na površinskim kopovima, Bor 2000
[4] Brahimaj I.; Brahimaj F.: Technology of drilling and blasting II, Mitrovica 2016
[5] Nuredini H.: Safety technique in mining, Pristina 2006
[6] Dzodic R.: Tehnologija busenja i miniranja, Pristina 1985