



ADVANCED MODERN TECHNIQUES FOR EXPLOITATION OF DIMENSION STONES

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ABSTRACT

In this paper work are given some techniques of the exploitation of dimension stones in some of the more important Mines in the Republic of Macedonia.

Will be describe the technology of exploitation of dimension stones, dumping of strips and the devices.

Excavation of stone blocks (marble, granite etc.) is one of the most important operations. Various devices and techniques are used depending on the kind of the mine, the capacity, properties of stone blocks and the efficiency of the equipment used in the quarry.

The manufactures of this equipment have a lot of different products but which of techniques will be use depends of character of the open pit quarry, capacity and physical - mechanical characteristics of dimension stone.

Keywords: *Dimension stones, Exploitation, Production, Techniques*

1.0 INTRODUCTION

Geographical position of Macedonia and geological conditions, caused to form the formations of many different rocks masses ranges with the presence of a large number of useful mineral resources.

Although relatively with small area Republic Macedonia is rich with a lot of different mineral resources metal ores, non - metals, rare minerals, dimension stone blocks for the architecture, energy raw materials (coal) and other raw materials that make Macedonian mining industry.

More significant research works to define the larger ore reserves to which were initiated and carried out in the middle of the XIX Century.

Since then today is made lot of numerous geological researches, mining research activities to a smaller extent and be established the new mineral fields with economic significance. All of this activities contribute to create conditions for development of mining industry as an important segment in the overall economy of the Republic of Macedonia.

The rapid expansion in exploitation and processing of architectural - dimension stone over the past years in the R. Macedonia, particularly in the region of Prilep, had as a result to open lot of small quarries for white marbles, granites, onyxes etc. at the present time.

These raw materials are almost with various entities throughout the territory of Macedonia and a large number of different quantitative and qualitative characteristics.

They represents a potential raw materials for the development of small quarries, small businesses for processing and shaping, which is have already been proven and in previous decades. With relatively small investments, limited resources and rapid turnover of the capital for several years, in these existing facilities are established stable low capacity, high quality raw materials and teams succeed for management and appearances on local and world market.

Especially here invoked the large number of low capacity for receiving and processing (large number of fractions with granulation from several microns up to several centimeters) of different types of limestone, igneous rocks of technical stone, and especially set as acquiring queries and processing of decorative white marble, with high quality with trade mark.



The Western Macedonian zone is present as several formations. The geological composition made possible the occurrence of number of rocks that can be used as architectonical - dimension and decorative stones such as: marbles, granite, gabbros, basalt, travertine, onyxes etc.

Today, the archeological investigation testify that the very well known Prilep marble was used. This stone from Prilep is an important raw material a base for the development of numerous open pit mine, small quarries and processing plants and lot of modern factory.

2.0 Methods of Technological process

In this paper describes some methods for obtaining marbles blocks in the "Sivec" - Mine, and "Bela Pola" - Mine, which are open pit quarry. The first method which describe is the use of drilling -blasting work and the second is use of diamond wire and cutting machines (Jet Belt). The paper shows tables of normative materials obtained after the methods, the conditions for their rational use as well as the cost of granite blocks per m³.

Extraction of granite and marbles blocks from the hard rock mass is done in some ways:

- Drilling vertical and horizontal drill holes and blasting charge, and
- Combined extraction with drilling, blasting and diamond wire sawing.
- Combinations with cutting machine and diamond wire.

Benches in the open pit are 6 - 8 m high. The height is conditioned by the structural-tectonic characteristics of the massif, and the technical characteristics of the machinery used during excavation. The height (1/2H) is also in favor of the dimensions of the final product - commercial blocks of 3.0 x 1.3 x 1.7 m in size.

- Drilling

After the working trench and the face for frontal excavation have been done, horizontal and vertical holes are drilled. Vertical drill holes are drilled at a distance of 15 to 35cm depending on the characteristics of the block and the manner of initiation. The distance between vertical drill holes is $a = 30$ cm.

This distance is not applied to rear drill holes that are of lesser number than the frontal. The distance between them should amount to 1/2 of the distance of the frontal drill holes.

The number of horizontal drill holes is the same as that of the vertical frontal ones. However, horizontal drill holes are drilled in the footwall at a zero angle of drilling (horizontal). The first horizontal drill hole should be spaced in the middle between the first and second vertical frontal drill hole. This pattern is done in order to eliminate possible overlapping of strikes of vertical and horizontal holes that may result in concentration of blasting material (explosive, detonating fuse and black powder) and excessive damage of the block. The drill holes pattern, the manner of connection and initiation are shown in fig. 1.

- Blasting

Successful blasting operation or technical separation of the hard rock mass from the entire rock mass requires the use of such blasting material that will provide minimum damages of the rock mass. At the same time it should split (rib - contour splitting) along the length of the vertical and horizontal drill holes.

In that regard, explosives used are as follows:

- Powder ammonium - nitrate explosive with cartridge diameter of 28-32 mm
- Detonation fuse class C - 12
- Black powder
- Detonating cap No. 8,
- Millisecond detonators with delay 17 or 20 ms.

When using detonating fuse, an increased action is applied in the end or at the bottom of the hole by introduction of several knots.

Blasting is carried out by connecting all ends of the detonating fuse with a detonating cord that is initiated with a detonating cap No. 8 connected with a slow burning fuse.



With blasting horizontal and vertical drill holes, millisecond delays of 20 ms are used. First the horizontal drill holes are activated and with a delay of 20 ms, the vertical drill holes are activated. In the cases where there are more vertical drill holes it is possible to use a second millisecond delayer placed at the centre of the vertical row of holes. The manner of connecting the rally connectors and the application of millisecond delayers is shown in fig.1.

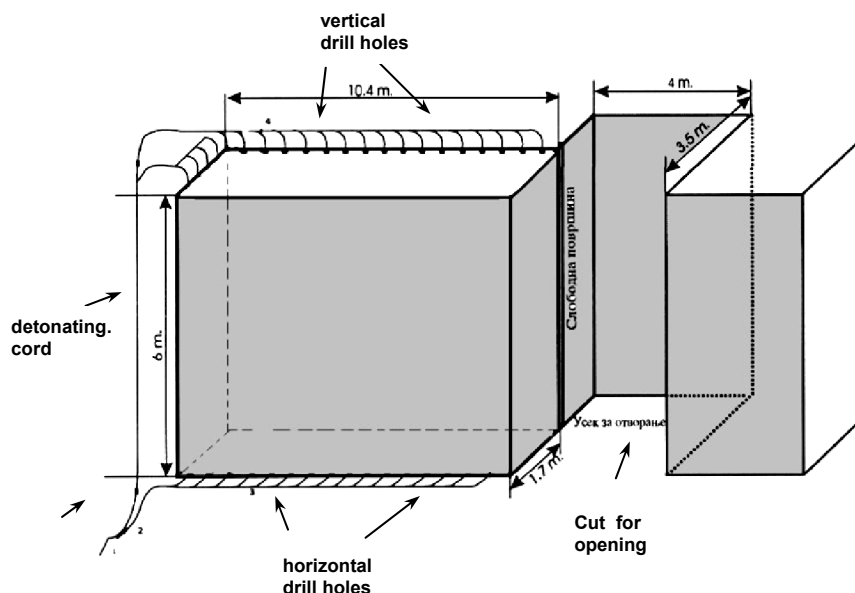


Figure 1. Pattern of vertical and horizontal drill holes and way of initiation

In the blasting of horizontal drill holes, black powder is used in every first hole and detonating fuse in every second hole. Sealing must be done well - with a clay seal or earlier prepared made of wet soil.

When using black powder, 50 to 70 g of powder are charged per hole, which means consumption of 200 to 250 g/m³.

In blasting vertical holes, every other hole (with even numbers) is charged (connected) with a detonating fuse and water, whereas the odd numbered holes (every first) are charged (connected) with a detonating fuse and 50 g. black powder.

- Block excavation by the use of Diamond wire saw

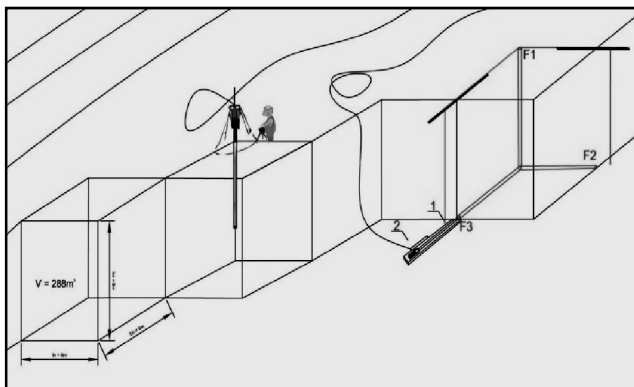
This method of obtaining blocks is applied to drilling-blasting operations, doing vertical (face and frontal) and horizontal cuts.

The cutting of lamellae with a diamond wire saw is done with two cuts. The first, the dimensions 6,0x1,7m is done from the rear side and the second, the dimensions 10,4x1,7m, is done horizontally along the bottom (fig. 2, 6).

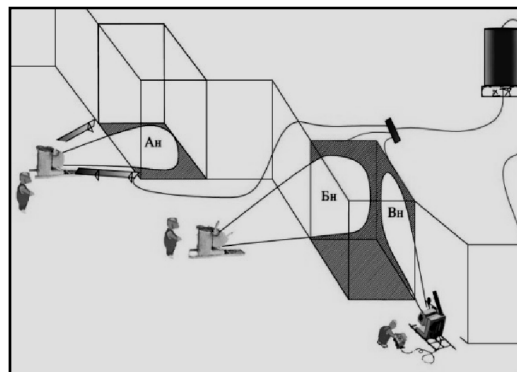
The Benetti PP 630 type perforator drilling machine is used for prepare the vertical and horizontal drill holes the diameter of 76 mm.

The vertical and horizontal drill holes should have the same direction to allow easy connection of the diamond wire saw. For the horizontal cut it is necessary to perform two horizontal drill holes - the first 1,7 m long and the second (normal to it) 10,4 m. long.

The diamonds wires saws machines which in use are: Telediam type 45-55S from the Pellegrini company, Marini mini fill", Diamond board " and Alfa 840 from Benetti machines company(Italy).



a)



b)

Figure 2. Preparing of drill holes for cutting, (a) Cutting of horizontal (An) and vertical (Bn) cuts with diamond wire (b)

-Block excavation by the use of cutting machines

With this techniques and methods of obtaining blocks is applied to doing vertical (face and frontal) and horizontal cuts.

The cutting of lamellae with cutting machine is done with one or two cuts and combine with diamond wire saw or use some blasting techniques

In Figure 3 is done some ways to prepare cutting with this techniques.

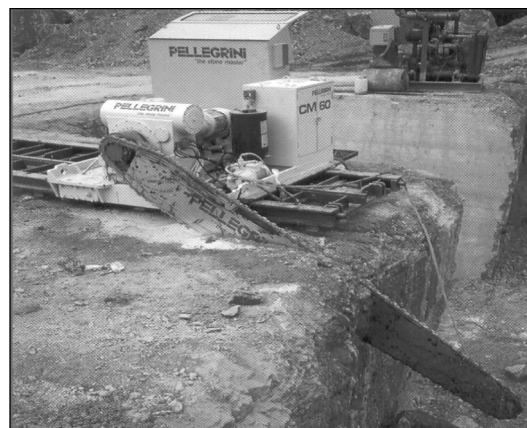
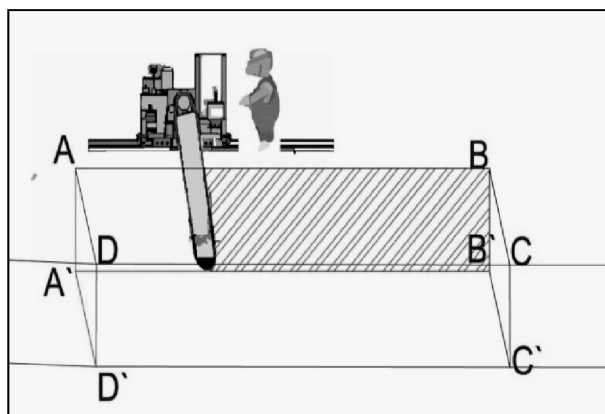


Figure 3. Cutting an vertical cut with cutting machine "Pellegrini CM60"

2.1 Dimensioning of Lamellae Obtained

The dimensioning of lamellae according to dimensions needed for further processing or commercial use is done with hand drilling machine by drilling vertical drill holes with small diameter (28 - 32mm) and hydro blasting detonating fuse and water. Holes are drilled at 20cm distance. Extraction of a block the dimension 3,0 x 1,7m from the lamellae knocked down is necessary to perform horizontal and vertical holes.

Another way to obtain the small commercial block from turning lamellae is to prepare vertical drill holes with drill machine directly to the blocks.(Fig. 4)

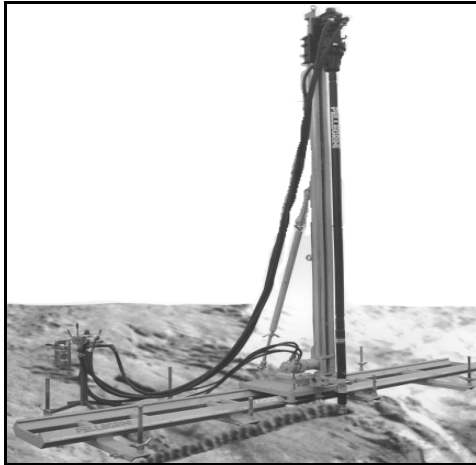


Figure 4. Drilling machine TBC SLOT



Figure 5. Drilling machine Perfora , tipe "Handu maxdrill hm02" in the open pit quarry "Sivec"

Exploitation of dimension stone from more open pit quarry for marbles in correlation and according to modern trends of development and application of technology for cutting of marble and another stones takes place according to the following methods in function of the Coefficient of utilization (Tab 1).

Table 1. Utilization of blocks marble massive according with different methods

No. of methods	Utilization of blocks marble massive (%)	Technology for exploitation (methods)
1	0 – 2,5	Drilling, blasting and cutting
2	2,5 – 10	Cutting with daimond wire - saw and cutting machine
3	10 – 40	With Cutting machines and...
4	>40	Exploitation only with Cutting machines " in city"



Figure 6. Diamonds wires saw machine tipe ALFA 840, Benettimachines , Verona, Italy

2.2 Loading and Transport of Commercial Blocks and Waste

Loading the blocks dimensioned from the working bench plateau is done with machinery, which should meet the technical-technological demands regarding the clearance dimensions and their weight.

For better use and efficiency, the shovel should be suitable for loading the blocks and the waste. In that regard, two holes, the diameter of 10 cm and distance of 1/3 of the width of the shovel, are made on the shovel.

During loading, wire ropes are put through the holes that will help lift the block and place it on the vehicle. Loading machine with different types are used (Fig. 7).

Haulage from the open pit includes moving the waste material from the working benches to the spoil heap and block haulage from the plateau of the mine to the plant for further processing.



For transport of cutting commercial blocks from the active benches and relocation of the commercial blocks of ground for loading and export in some quarries are in use Derrick machines - cranes, (fig. 8).

Waste disposal is carried out occasionally according to the construction of benches.

The waste is dumped into the landfill close to the open pit. The distance between the working benches and the landfill is from 200 to 400 m. This distance is relatively small and allows easy disposal of waste material.



Figure 7. Loader tipe Catt 988

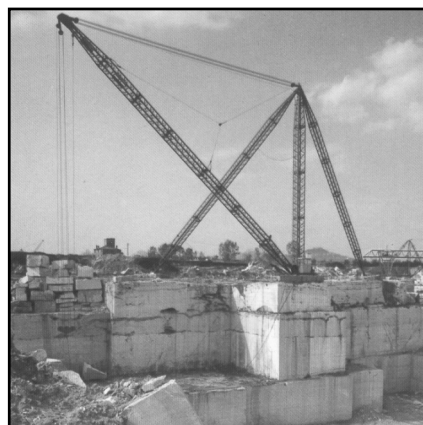


Figure 8. Derrick crane in the "Sivec" quarry mine

The use of diamond wire saw, cutting machines in extraction, exploitation of blocks (dimension stone) and methods of drilling and blasting are very specific operations.

Further studies should include the possibility of the introduction of new techniques and methods in exploitation in order to reduce drilling activities and consumption of blasting materials (explosives) and damage the granite mass. The introduction of new, up to date technologies in excavation will result in better effects and greater productivity.

3.0 CONCLUSION

Over the past several years Macedonian stone industry has seen fast increase in export, from \$7 million in 2002 to more than \$15 millions in 2005 with over 1500 employers. In past 2-3 years the export increase with 20 -30% for all types of commercial dimension stones.

Several kinds and unique quality dolomite white marbles, onyx, travertine, granite etc. are a real stone potential and invaluable wealth that the Republic of Macedonia abounds in particularly the region of Prilep. This has also been acknowledged by more than seventy concessions issued for exploitation of dimension stone of which, forty-five are for the region of Prilep.

Our opinion is that is right moment for the economy in the country to do something more in order to promote and protect the regions that abound in ADS.

However, we will present our ideas in a resume. Considering all above mentioned itineraries, We are confident that in the years to come, with our enormous efforts, the industry for architectural-dimension stone in the Republic of Macedonia will see real expansion, in correlation with the global world economy in this sector.

LITERATURE

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