

EQUIPMENT FOR TURNING DOWN OF DIMENSION STONE

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ABSTRACT. The paper describes technology of dumping strips and devices. It also illustrates latest equipment in quarries. Technology of strip turning down consists of several integrated phases and continuous operations (hydraulic cylinders or pushes). Experiments show that the kind of equipment used depends on the character of the open pit quarry, capacity and physical and mechanical characteristics of dimension stone etc. Hydraulic cylinders are not widely used in the Republic of Macedonia.

ОБОРУДВАНЕ ЗА ОБРЪЩАНЕ НА КАМЕННИ БЛОКОВЕ

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РЕЗЮМЕ. В доклада са представени технология и техника за разтоварване на отривка, както и актуално оборудване в каменни кариери. Технологијата за обръщане на отривката се извършва на няколко етапа и в рамките на непрекъснати операции (чрез хидравлични цилиндри или други хидравлични устройства). Опитите показват, че видът на оборудването, което е необходимо зависи от конкретната кариера, капацитета и физико-механичните характеристики на камъните и т.н. В Македонија най-често се използват хидравлични цилиндри.

1.0 Introduction

In this paper will be describe the technology of dumping of strips and the devices. The paper will also give an account of latest equipment used in quarries.

In excavation of stone blocks (marble, granite etc.) dumping or turning of sawed strips on the front part of the block 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.

1.1 Description of Basic Technology

Turning down of earlier sawed (separated strips of the mass) is a special operation in obtaining marble, granite and other blocks. Strips are separated and turned down (in our quarries for example) using traditional methods in all quarries. An exemption is the method of strip dumping with hydraulic loaders a special technology. It is simple but with great risk.

Before turning down an earth bed should be formed on which to dump the strip. It serves as a protective layer. The earth bed is done with a loader placing finely crushed earth, or earlier excavated overburden. Care should be taken not to

have large pieces of stone on the bed in order to avoid breaking of strips during turning down. Care should also be taken the earth bed not to be too wet, with much sand or mud that can spread out and allow breaking of strips during turning down.

The thickness of the earth bed should be from 0.5 m to 0.6 m at the beginning or near the foot of the strip. Further from the strip, the thickness increases amounting from 0.8 to 1.0 m depending on the height.

The following equipment is used in strip turning down in mines for dimension stone with traditional methods or technology:

- hydraulic cylinder set (dumpers),
- hydraulic wedges, (fig. 4)
- special hydraulic cylinder,
- pneumatic or hydraulic divaricating cushions,

The technology of dumping includes several ways of strip turning down depending on the equipment used. Most common methods are:

- turning down with hydraulic cylinder
- turning down with air cushions,
- turning down with water (steel cushions)
- combined turning down of strips.

2.0 Turning down - tipping of strips with hydraulic cylinders set

The technology of strip turning down consists of several integrated phases and continuous operations.

Fig. 1 shows a method and phases, of separating and turning down a strip with hydraulic cylinders or pushers.

First, it is necessary to make a platform on the top part of the mass, behind the sawed strip on which cylinders are placed.

After the hydraulic cylinder is placed on the platform behind the sawed strip, with the help of hydraulic pump, which is connected with hoses, the piston that pushes the strip is pulled. During turning down, and as the slot widens, wood support and stones are placed in order to avoid moving the strip backward. After the piston is pulled completely, it is sent back and the hid. cylinder is lowered as long as the strip is turned down.

Care must be taken since, at the moment of turning the strip, hydraulic cylinders are relaxed and may fall and damage. So, it is necessary to tie them with wires or ropes. As the slot between the strip and the hard mass increases and widens, stones are put to prevent movement of the strip backward and relax the hydraulic cylinder.

When it opens to a maximum, the second pusher is placed with a rope lower than the depth on which it is open to a minimum. This starts pushing the block.

The process can be repeated several times as long as turning down of the strip is achieved. At that time hydraulic cylinders are freed so that they may fall on the bottom. To avoid this they must be tied with ropes. Before this is done, a layer of crushed pieces of material is placed under the strip to absorb the strip bump on the ground.

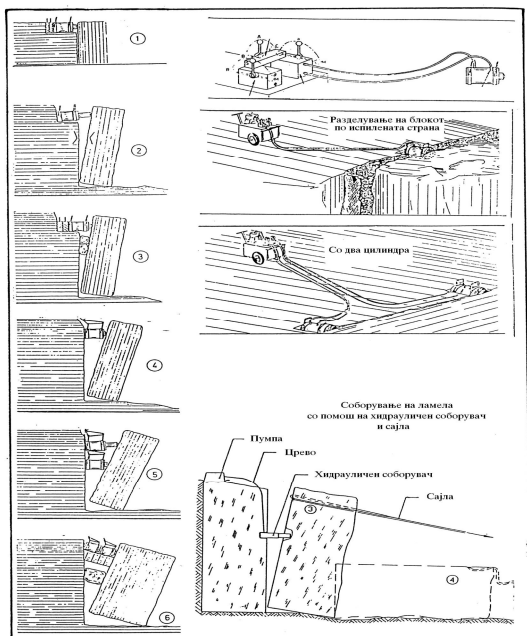


Fig.1. Phases of strip turning down with hydraulic cylinders

Where:

P = P_m , thrust [N],

A - Strip width, [m],

H - Height of sawed strip, [m],

M - Strip mass, [kg]

G - Earth acceleration, [m/s²]

$m = \gamma V$ [kg]

2.1 Necessary number of hydraulic cylinders (dumpers)

The number of hydraulic cylinders needed is decided based on the size of the necessary moment of turning which is obtained from the cylinder thrust which must be higher than the static moment of the strip (fig. 2).

By equalizing the two moments one can obtain the thrust necessary and decide on the number of hydraulic cylinders. According to fig. 2 it is obtained:

$$P = \frac{a}{2h} mg$$

$$mg \frac{a}{2} = Ph$$

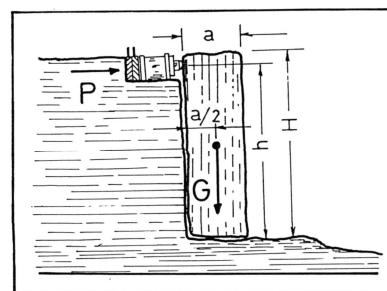


Fig.2. Determination of thrust necessary for turning down the strip

γ - Volume weight, [kg/m³]

V - Volume of the strip, [m³]

The value obtained for the thrust increases by the coefficient of safety of 15%. In this way, the necessary thrust obtained is:

$$P_s = 1,15 \cdot P_m$$

The number of hydraulic pushers - cylinders is determined according to the ratio of the strip (G_{lam}) and the necessary value of the thrust P_m :

$$N_{pot} = G_{lam} / P_m \text{ (number of hydraulic cylinders)}$$

Hydraulic pushers (cylinders) are equipped with aggregate with pump that exerts pressure on the hydraulic oil of over 700MPa with automatic regulation for one, two or more hydraulic cylinders of various thrust and various stroke of the piston.

The operating motor of the pump is the capacity of 2.0 kW or more depending on the type and the thrust necessary. The aggregate is equipped with a valve for over pressure, distributor valve, valves for separation (distributors), manometer shock absorbers, oil tank the capacity of 25 l and special flexible hoses for pressure with special rapid joint couplings. The aggregate is placed on a small barrow with rubber pegs.

Four types of hydraulic cylinders with the following characteristics are used in up to date technology in our quarries for obtaining stone blocks.

Table 1. Types of hydraulic cylinders

Type of cylinder, set	Stroke of piston mm	Piston diameter mm	Cylinder long, mm	Thrust kN
1	50	230	230	1500
2	100	230	280	1500
3	150	230	330	1500
4	300	170	480	680

In strip turning down it is good to use two cylinders - one 300-mm stroke of piston along with two 150-mm stroke cylinders. The former possesses lower thrust (of about 700 KN), but since it is used with inclined strip, the force is sufficient to turn it down.

3.0 Hydraulic wedges

The way of using of hydraulic wedges is show in fig. 3. According with figure 3 the way of use is show.

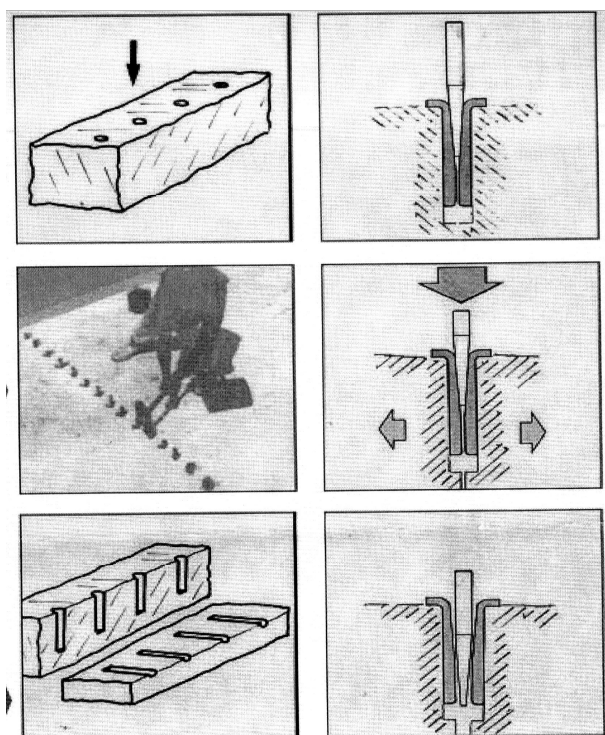


Fig.3. Introduction of lubricated splitting wedge after drilling operation

In first must be make some borehole and the number depend of width of strip. This drilling operation can be prepared with classic drilling machines with small diameter usually 28,32 or 40 mm. After this operation must be make tension with hand hammer. Tensioning of the splitting wedge by means of hand hammer and the effect after splitting is show also in fig. 3.

Some technical characteristics are show in tab. 2.

Table 2

Diameter (mm)	Wedge length (mm)	Distance between holes (mm)	For cutting height, description
22	130	50-100	low height
29	250	100-150	medium
29	450	100-150	high
34	350	150-300	medium
34	600	150-300	medium, high
34	750	150-300	high

3.1 Special hydraulic splitting wedges (Minisplit)

This wedges considerable reduction in size and weight with respect to classic hydraulic wedges while maintaining the same splitting force. The special wedges can be inserted into the hole to the depth required. We can also to connected several wedges in series. (Fig. 4).

In the diagram we can see three different ways of using the hydraulic wedge:

- Wedge is placed near the beginning of the blast-hole;
- Wedge is placed toward the bottom of the blast-hole;
- Wedges are connected in series along the whole length of the blast-hole.

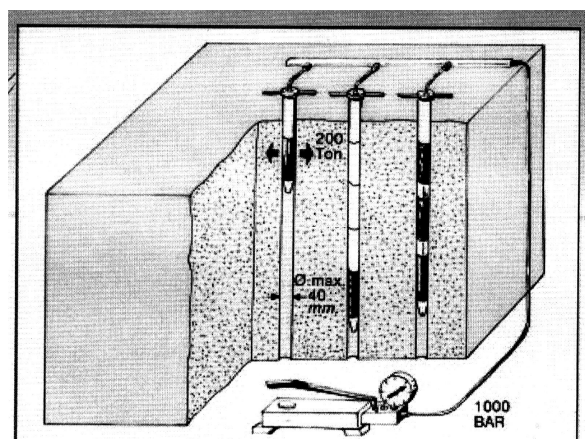


Fig.4. Different ways (three) of using the hydraulic wedges

A great advantage of this kind of wedge is that can be placed anywhere inside the hole in such a way as to get a concentration of pressure at any part of the plane of split.

The force of each of this wedges (with pressure of lubricant - special oil of 1000 Bar) can be up to 200 t.

Some technical characteristics of this wedges is:

Required hole diameter . . . 40 mm

Wedge length 530 mm

Wedge weight 3 kg

Splitting capacity (P=1000bar) . . . 200 t

The another overturning and squaring equipment and machinery wick are used for this operations are: Splitting bags, Hidraulic jacks, Manual rock - splitting wedges, Mechanical rock - splitting wedges etc.

Conclusion

At the moment the exploitation of dimension stone are in use more different methods and techniques for turning down of strip (marble, granite etc.)

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 etc.

In the Republic of Macedonia, more often are used the Hydraulic cylinders, Splitting bags, Hydraulic pneumatic or

hydraulic divaricating cushions and loaders with hydraulic bucket.

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Recommended for publication by Editorial board