INITIAL STEPS TO DEVELOP A CUTTING AND HAULING ADAPTER FOR DIMENSION STONE MINING

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Abstract: The aim of the MIOCÉN project is to develop of a small volume mining production and transport adapter suitable for. The tool to be developed for both production and transport can reduce the number of mining machines to be used in the mine. It is planned to reduce the expenses of running mining businesses, which include mining operations, costs of maintenance. This paper shows the development of a dimension stone mining adapter for a Construction Loadall base machine.

Keywords: development, mining, limestone, prototype, adapter

1. INTRODUCTION

The aim of the MIOCÉN project is to develop of a small volume mining production and transport adapter suitable for limestone. The research optimizes the production of small volume dimension stone products – mainly in limestone quarries - with the re-thinking of the use of production and transport equipment. The tool to be developed for both production and transport can reduce the number of mining machines to be used in the mine. It is planned to reduce the expenses of running mining businesses, which include mining operations, costs of maintenance. The goal is to be cheaper on the market and to be more competitive with the companies in the market (Molnár et al., 2018).

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2. LIMESTONE LEITHA

The determination of the mined rock environment was essential for the design of the adapter to be developed and the selected technology. The rock selected from the point of view of the project is the limestone Leitha in the Sopron Mountains, which is the main component of this area. The name of the stone was derived from the Leitha Mountain (or river), which separates the former Hungary from Austria.

The limestone in Fertőrákos and in Margitbánya (located in Austria) has been a popular building material for millennia: the Celts and the Romans living there used this stone as well. The nearby Carnuntum (near today Vienna) and the buildings and the protective walls of Scarbantia (Sopron) are made of this material.

It became a popular building material from the 18th century. They were easy to mine and transport, massive amounts of blocks were transported to the buildings of nearby big cities. Much of the houses in Vienna and Bratislava were made of this material, but in almost every village around Sopron we find buildings built from "Rákosi" stone. At first only the temples were built out of it (e.g. the Saint Michael church in Sopron, Stephansdom in Vienna), but soon it was the basic material of the residential buildings. We could mention the Esterhazy Castle in Fertőd or the Festetics Palace in Keszthely (Fig. 1.). In addition to the building work, it also served as a base for many tombs, memorials and sculptures.

Fig. 1. Festetics Palace in Fertőd (Wikipedia)

Rákosi limestone is moderately resistant to weather, so it is best to use in plaster finished structures. The example of the Trinity of Kőszeg has been a good example of the relatively poor resistance, which was set up in 1713, but since it has been restored 3 times (1813, 1869 and 1974). The pedestals of the Buda Castle buildings were made of this stone (the stones which were recently removed from

Margitbánya, unfortunately they are also destroyed by the salting of roads and pavements). These future reconstructions need have justified our choice of cooperation with “Fertőrákosi II” limestone quarry.

The Rákosi limestone is 100 - 150 m thick, large-grained shallow-sea sediment. Its material is made up of reddish algae, snails, shells, sea-urchins and bryozoas. The color of the rock is yellowish-white. Its density is between 1750 kg/m3 and 2500 kg/m3 in the air-dry state. Its compressive strength is typically around 10 MPa. (Mednyánszky, 2017, Török, 2008).

Fig. 2. A building stone mine

3. METHODS OF PRODUCTION OF DIMENSIONAL STONES

It is imperative to know the geological knowledge of the site and the use of the extracted material to develop the rock winning technology. Based on these, we must choose which way to start optimally in the development.

There are several versions of the dimensional stone production, which are:

a) Block production with a large borehole blasting technology, in which we create oversize blocks, which require further cutting or shaping.
b) Cleavage of stone blocks using chemical swelling energy. One way is to use water-swellable mixtures for rock fracturing purposes.
c) Use of mechanical, hydraulic and combined rock setting wedges placed in small-diameter holes. Hydraulic units consist of a high-pressure hydraulic unit and a tensioning tool. Owing to the high-pressure hydraulic unit the wedge tensioning tools cause tension to the

walls of the holes, thereby developing tensile stresses in the stones between the holes.

d) Creating blocks by drilling when the boreholes are drilled densely along the contour of the block so that they are in contact or interconnected.

e) Rock sawing, which can be done with disc, chain and rope. The gentlest block production method is the sawing of blocks. For the smooth operation of the rock saws it is necessary that the rock is free from cracks.

To mining blocks in a place where blocks are not sawed, a large number of boreholes are needed. The boreholes have to be spaced from 15 to 40 cm apart to allow the rock to be fractured along a certain plane.

Since the gentlest production method is rock sawing, and to reduce the number of machines, we plan to solve the production with a design that is capable of winning and transport.

4. THE PROTOTYPE ADAPTER

The basic machine for the adapter is provided by a JCB Construction Loadall (Fig. 3.). Due to the large load capacity and design of the machine, it is used for different workflows in many areas. Its multifunctional applicability ensures that the hydraulic system of the requested machine has a pump capacity of 140 l/min and a working pressure of 260 bar.

Fig. 3. The basic machine of the project, a JCB Construction Loadall

Based on the new technology, the adapter can be disassembled into two main units. One of them is the cutting chain saw unit combined with a feed and rotation hydraulic system and a hydraulic rotary unit. This part of the adapter can cut from three sides perpendicular to the front face.

The structure of the rock chain saw contains individually manufactured elements, such as chain-shaped teeth, which are formed in a specific, unique order on the chain and form 5-11 teeth-repeating chains, specially developed for rock quality. Fig. 4. shows the chosen chain form. The shape of the cutting device is very important because of the cutting forces and loads (Tomus, O. B., Rada, A. C., 2017). High loads can produce unwanted effects on mining system (Andras et al., 2016). During design the chain guide should be designed separately, which should consider the lubrication system to be used to reduce friction during operation.

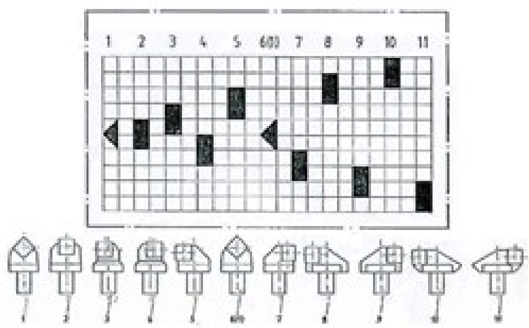

Fig. 4. Special chain saw elements

The other main machine unit serves to support and move the first main unit while cutting and performs stability and elevation of the block with an object table, which is subject to heavy wear and tear during the mining use.

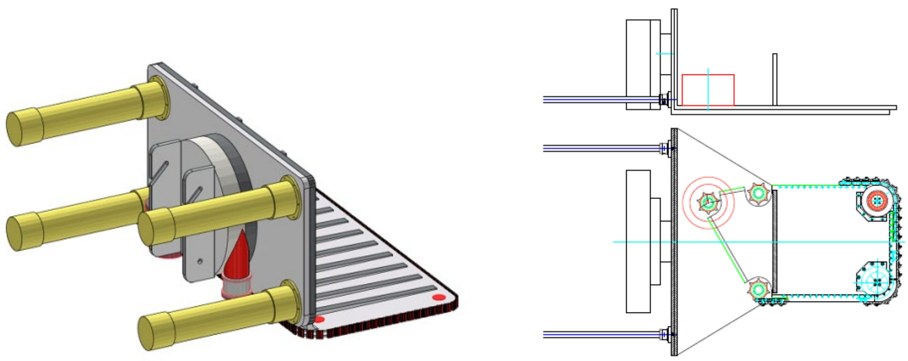

Fig. 5. Two initial versions of the prototype adapter

Testing the prototype adapter (Fig. 5.) is unavoidable during the development period, which will be carried out at the manufacturing workshop and in the limestone quarry. During testing, the static and dynamic uses of the units in the adapter are studied, even in extreme cases, to determine the more accurate technical parameters.

5. CONCLUSIONS

Future reconstructions of historic buildings, tombs, memorials and sculptures need good quality dimensional limestones. This is why we start a new project to design a mining adapter. To develop the rock winning technology, it is imperative to know the geological knowledge of the site and the use of the extracted material. Based on these, we must choose which way to start optimally in the development.

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