ACCESS ROADS TO THE OPEN PIT BENCHES OF A STONE QUARRY WITH VERY DIFFICULT RELIEF CONDITIONS

MOLDOVAN Dorin Vasile

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ABSTRACT

Together with performing more and more intense activities in the field of road infrastructure, the amount of quarry natural aggregates needed has increased considerably so that new sources for raw materials had to be identified. These sources are situated in areas where the automotive transport means though which the materials could be transported to the public roads networks reaches with difficulty.

Keywords: 3D Modeling, Access roads, Quarry

INTRODUCTION

The Mermezeu andesite deposit is situated on the Onășel hill, in the south-east end of the commune of Stânceni, Mureș county.

Fig.1. Natural terrain conditions

1 Eng., Tehnical University of Cluj-Napoca, Faculty of Civil Engineering, e-mail: dorinvasilemoldovan@yahoo.com, Romania
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The access to this perimeter is made on road DN 15 Deda – Toplița, wherefrom to the north a service road of about 4 km along the Mermezeu rivulet is diverted.

The deposit of andesitic rocks from Mermezeu is a massive body of rocks developed above the Mermezeu rivulet to the north-south in a length of about 155 m and to the west-east of about 260 m long.

The mining surface, according to the sheet of the area, is 4 ha, Fig.1. The mineral rock exploited in the mining perimeter of Mermezeu is andesite, a volcanic rock that is processed and used as a building material, Fig.2.

The design topic requires designing the access roads to the quarry benches, of the consolidation solutions in relation to the roads, the collection and drainage of the rain waters.

MATERIAL AND METHOD

1. The Designed Solutions

Taking into account the property limits, the extremely difficult relief conditions, the recommendations in the norms and the elevations required for the open-pit benches, we resorted to the dynamic modelling and designing the paths of the roads by means of software Fig.1.

The curves were calculated according to STAS 863-85 for class V, with the minimal design speed of 25 km/h. In the plane, the path has radius...
of 20 to 200m arranged according to STAS 863-85. Over wide varying between 0 and 3,50m placed inside the curves were also designed.

2. **The Horizontal Design**

The path projected contains three access roads:

- access road I connects the quarry base from elevation 839 to the bench at quarry elevation 885, in a length of 580m;
- access road II joins access road I at elevation 856 to the bench at quarry elevation 865, having the length of 70m;
- access road III connects access road I from elevation 884 to the upper plateau at elevation 905, and has a length of 211m.

![Fig.3. The projected lay-out](image)

In plane, the path is formed of a succession of curves and alignments following the outline, to lead to a minimal slope, in longitudinal profile, for the existing situation and the elevations required by the technological quarry benches (Fig.3).

3. **The Longitudinal Profile**

In the longitudinal profile, the red line was projected with respect to the conditions of the ground so that a minimal slope results and provides the
access to the open-pit benches function of the mining stages and the thickness of the road system given by size computations and by STAS 863-85 provisions.

In the longitudinal profile, the minimal projected slope is 6.67 %, and the maximum slope is 12%. The road red line was also projected so as to allow for the draining of the waters on the road platform.

Water drainage concerned the design with trapezium shaped ditches, with a depth of 60cm that enables both the draining of the water on the road surface and of the road system, too. Guarding trenches of trapezium form were also projected at a height of 30 cm for the collection of the water from the hills and slopes (Fig.4).

4. The Typical Cross Section
   The geometrical elements in cross sectional profile will correspond to roads belonging to class V that is to quarry mining roads:
   - the strip (7.00 m);
   - the carriageway (6.00m+overwide);
   - hardened shoulders (2x0.50 m);
   The gradient in shape:
- the carriageway - 4.0%;
- hardened shoulders - 4.0%.

Guarding trenches were also provided. The road cutting area will have a 2:1 slope, in the unprocessed rock. The road fill area will be consolidated with gabions. Fences will be mounted for the safety of the traffic (Fig. 5).

The vegetal soil and the sterile volumes obtained after excavations will be deposited in the external refuse; the vegetal soil will be separately deposited and further used to recover the ground appearance at the end of the works.

![Typical cross section No. 5](image)

**Fig. 5. Composite typical cross section**

5. **The Road System**

The road system will be made from:
- 25 cm crushed stone in an optimal mixture 0-63 mm – running layer,
- 35 cm rough stone block of maximum diameter <250 mm wedged with sorted rocks 0-100 mm – foundation layer.

The transverse profiles of the road are typical of cutting areas, for the majority of the route, to avoid costly consolidation works.
In order to consolidate the main body of the road, abutment fill of gabions were designed, at a total length of 135 m and a height varying between 3 and 6 m (Fig.6, Fig.7).

6. **3D Modelling**

   Due to the complexity and high difficulty of the work, we made use of design computer assisted software for roads.

   This software allows for the three dimensional modelling of the digital pattern of the road, of the road paths as projected and of the volumes needed to be dug and used to fill the area.

   The software also allows for the modification in a dynamic manner of the path and the automated updating of the project making possible the tracking of the modifications in the design and considering the amplitude of the consolidation works, this being the most important aspect.

![Fig.6. Designed cross section]
The 3D modelling of the projected roads helps better understanding the works to be performed and also a digital model of the works that helps people without expertise in this field to clearly see and understand the extent of the works to be carried out (Fig.8.).
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CONCLUSIONS

Such a development requires designing and building access roads for these quarries that are optimal with respect to initial investment costs and further maintenance costs. Another very important aspect concerns the provision of the safety conditions for the traffic.

Only the use of design computer assisted software permits a better selection of the routes in a shorter time, a dynamic and automated modification of the paths, a three dimensional visualisation of the digital model of the ground and projected roads.

Due to the restrictions imposed by the relief, by property limits and elevations to the projection mode, spectacular solutions are generated where the access of the automotive transport to the open pit benches of the quarries is made much easier.

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