GEO-MECHANICAL CHARACTERIZATION OF THE A3 MOTORWAY ROUTE COMARNIC-PREDEAL IN THE CHOICE OF TUNNELING TECHNOLOGY EXECUTION WITH EXPLOSIVES

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Abstract: An efficient transport infrastructure, connected to the European transport network contributes to economic competitiveness, facilitates integration into the European economy and the realization of new domestic activities.

The current situation of the national transport system is characterized by a reduced number of highways..

1. Introduction

Romania has established guidelines for communications of European and national interest by National Spatial Plan, Section I "Ways of communication". Among the projects to which participates in the development of trans-European transport, also belong the highway Bucharest – Brasov. Highway is designed with 4 sections: Bucharest – Moara Vlasiei, Moara Vlasiei – Ploiesti, Ploiesti – Comarnic and Comarnic – Predeal.

The road no.3 of the motorway is planned to run the route localities Comarnic – Sinaia – Busteni – Azuga – Predeal, on the Prahova river bed and in the immediate vicinity of the river, going through the Prahova Valley a distance of 36.2 km.

An analysis of rocks crossed by tunnels, in terms of characteristics used in the construction of the tunnels, by classification Romanian Geological Committee, led to the following conclusions highlight the possible groups of rocks:

- Hard limestone marl and calcareous sandstones belonging compact layers of necomian Azuga or Sinaia, may be classified as very hard and hard rock, with a coefficient of rock strength of 6 - 9 and diffusion approx. 50%;
- Marls of necomian can be classified as hard or semi-hard rocks, with coefficient of rock strength of 3 – 7 and diffusion approx. 30%;
- Shale sandstone clay belonging of necomian layers of Sinaia can be classified as semi-hard rock, with a coefficient of rock strength 2 – 7 and diffusion approx. 20%.

In terms use of explosives, limiting factors are given for social and touristic objectives (Comarnic, Posada, Sinaia, Poiana Tapului, Busteni and Azuga), industrial facilities near the motorway and neighboring towns, not least the many protected areas included in the network NATURA 2000.

To carry out highway is necessary the execution of works both in size: at the land surface (excavation, leveling and grinding slopes), and also underground by executing of two tunnels near the village Azuga.

The works will take place on the land surface will run both the low strength rocks and the hard or semi-hard rocks. If are the soft rocks, cohesive or slightly cohesive work will be carried out with mechanized, and if are the hard or semi-hard rocks, blasting will be carried out with explosives.

Marl, clay shale belonging to the bar Comarnic Aptian layers, according Romanian Geological Committee classification, can be classified as semi-hard rock, with a strength factor of 3 to 5.

In order of blasting with explosives to be used the following techniques:

- Mine holes, when blasting front height is up to 10 m;
- Inclined boreholes, when the height of the works is more than 10 m.

Boreholes drilled inclined towards the vertical have the advantage of a more uniform distribution of the explosive in massive, a break and a more uniform slope. In order to achieve stable slopes, holes in the last row will have a smaller diameter than the rest of the device, the distance between them will be smaller and reduced loads.

Along the studied route in Prahova River defile areas, cross slope of mountain slope involve expensive building works of consolidation and a very large volume of excavation.

Taking into account the fact that the strip of land between the river and DN1 is furnished extensively with various constructions, or forest, that is necessary to study variants of solutions that minimize negative environmental impact that may have these excavations.

In this situation, we considered the embodiment of tunnels with separate section for each track, which allowed the better registration of the existing relief within the meaning of design, two tunnels from km 142+000, respectively km 144+307 which reduced both costs and negative environmental implications.

Adopting separate tunnel solution proved to be the best solution in terms of economic and relief.

To achieve tunnels will be observed the same sized specified in STATE 2924 concerning the bridges, but taking a higher safety space given the

free movement of road vehicles and the need for more intense ventilation.

Thus, the tunnel dimensions afferent of one sense of movement, motorway, dual-lane, emergency tape and pavement in 12 meters and the height is 8 meters.

Bedrock on the highway sector portion where I studied and considered it preferable to run tunnels, is the "layers of Sinaia" which are overall predominantly "flysch slate sandstone" with or without marls limestone, with intercalations of breccias and shale.

First tunnel proposed to run we meet near the locality Azuga and he has 2.30 km in length, in its continuing, on the next slope, will be the next tunnel and he has 4.60 km in length.

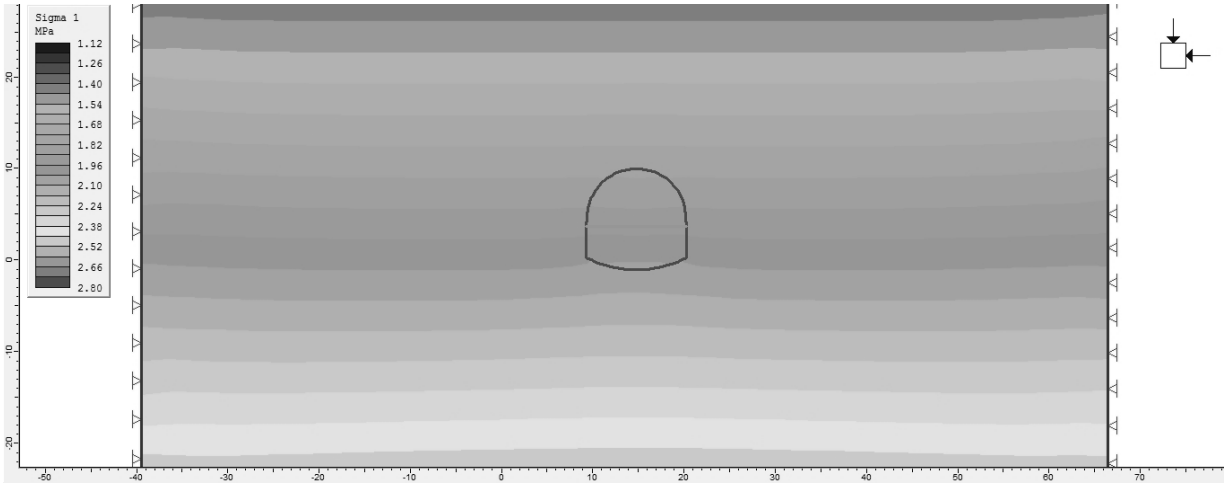
To choose the optimal version of shot perforation, we performed a comparative study of the advance by firing two-stage drilling advancement or advance with one free surface. Modeling was performed with the program Phase 2, such as making the modeling we can see the impact that has on the massive rock use of explosives.

Considering the rocks around the excavation and excavation dimensions, we conducted this study to observe the stress distribution around the work, for each type of advance in part.

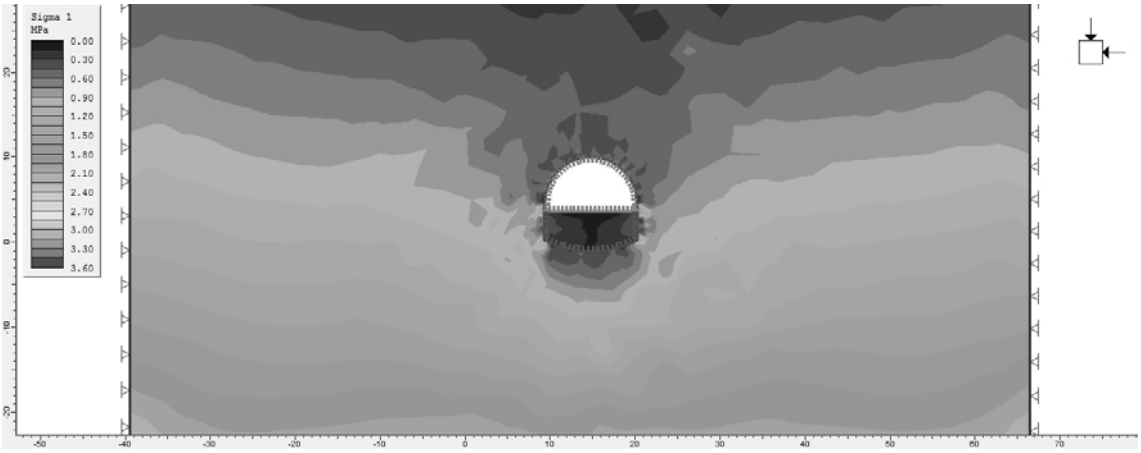
2. Advance by two steps of excavation

Highlighted tensions for if it used two stages of excavation are shown, graphically, as follows:

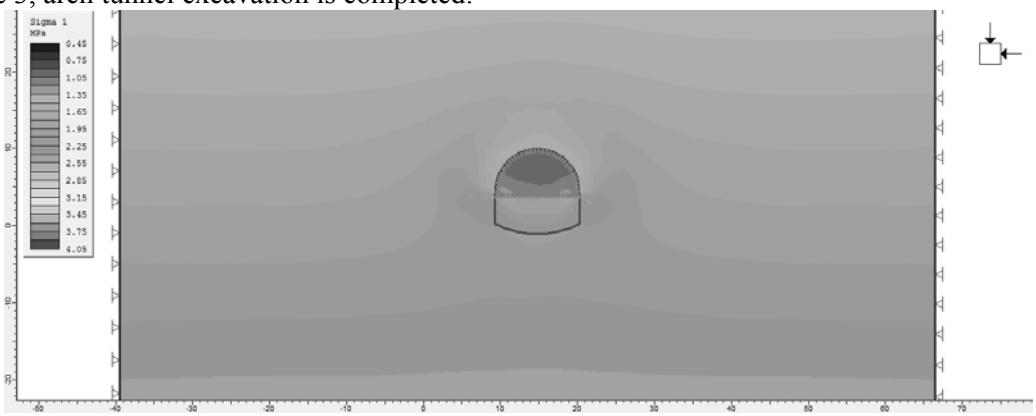
- The first stage, excavation did not start:



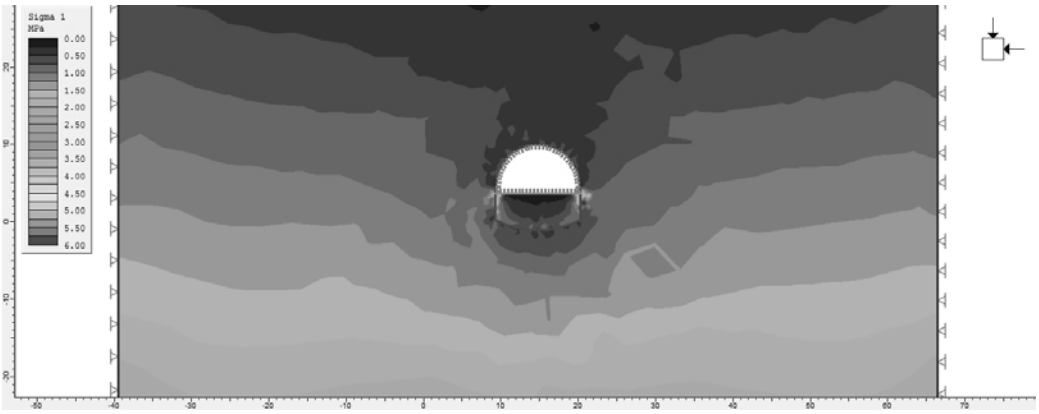
- For stage 2, start first stage, excavation vault:



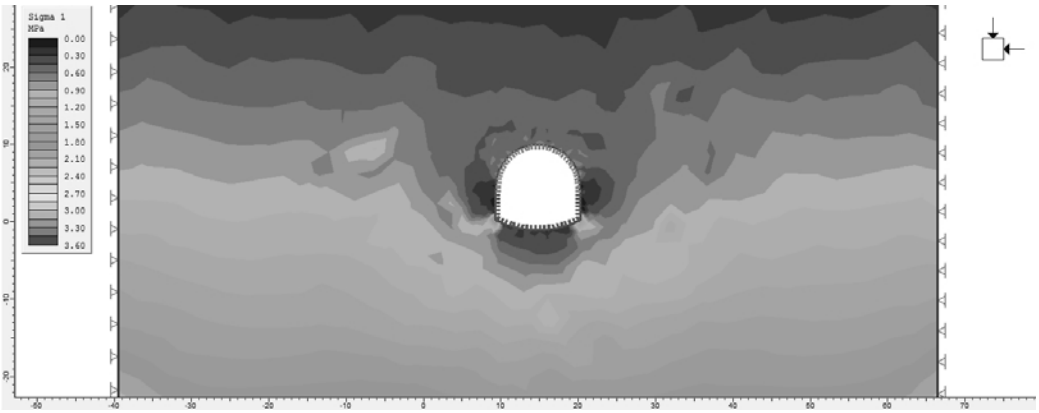
- For stage 3, arch tunnel excavation is completed:



- For stage 4, starting excavation of second stage:

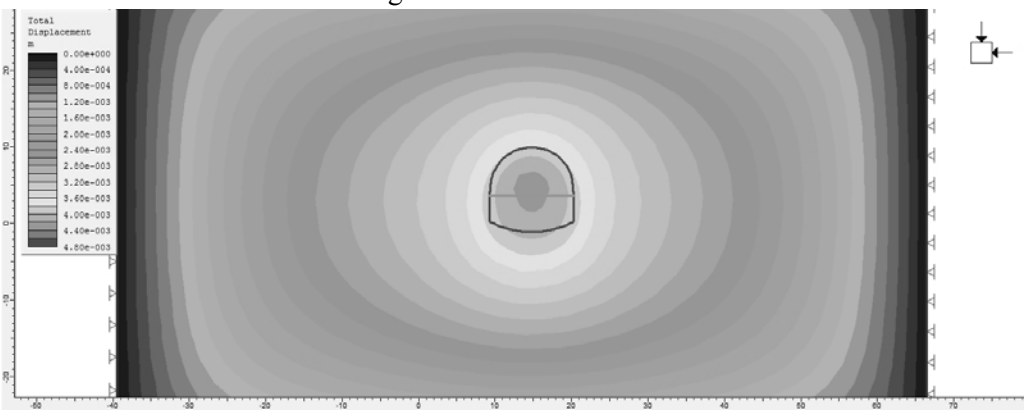


- To stage 5, the excavation is complete:

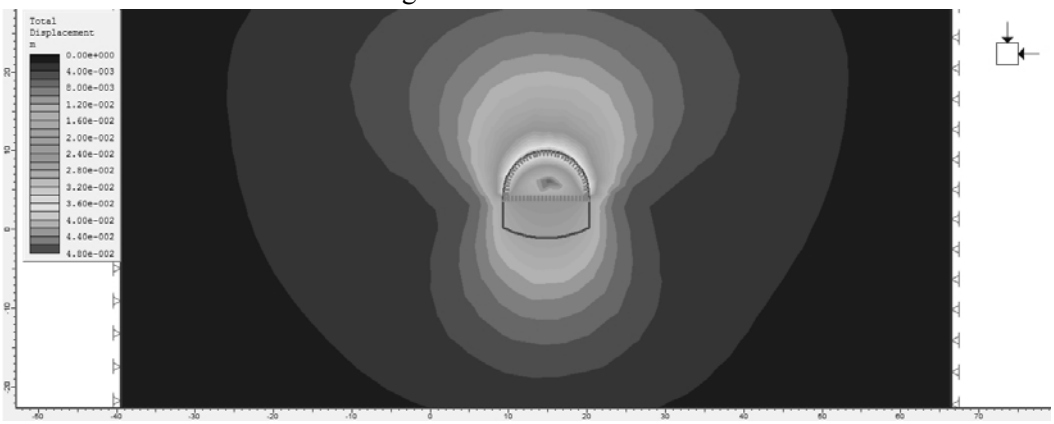


The interpretation of results for horizontal and vertical movements is follows:

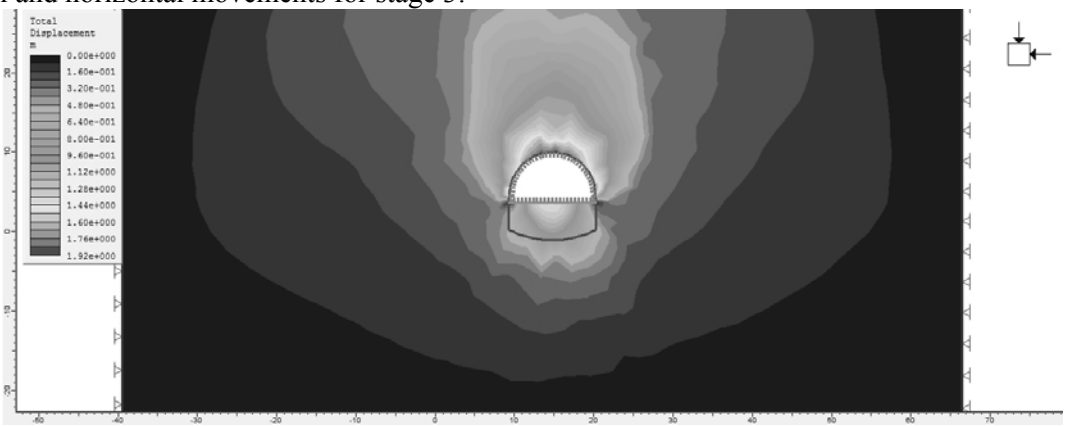
- Vertical and horizontal movements for stage 1:



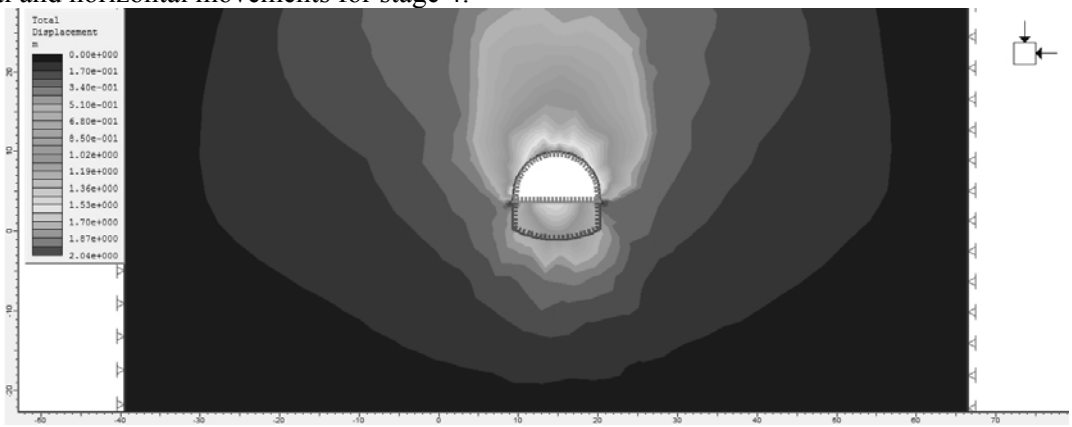
- Vertical and horizontal movements for stage 2:



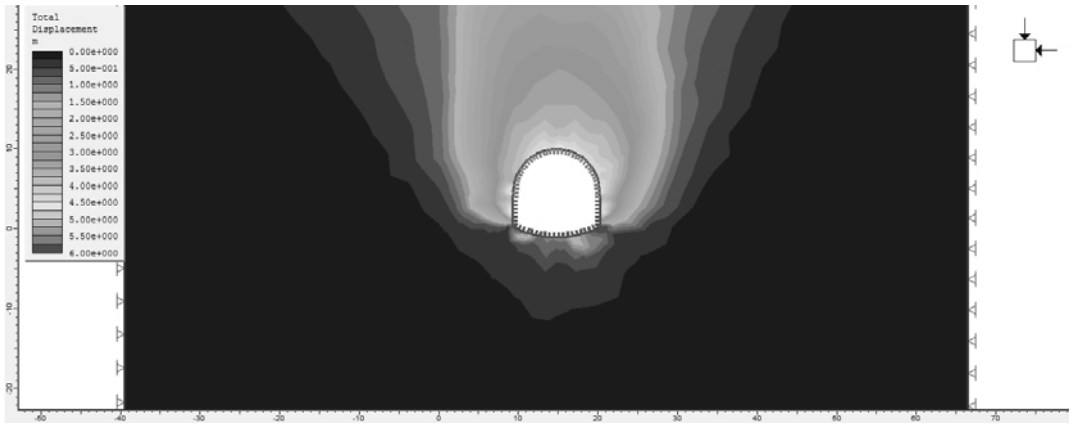
- Vertical and horizontal movements for stage 3:



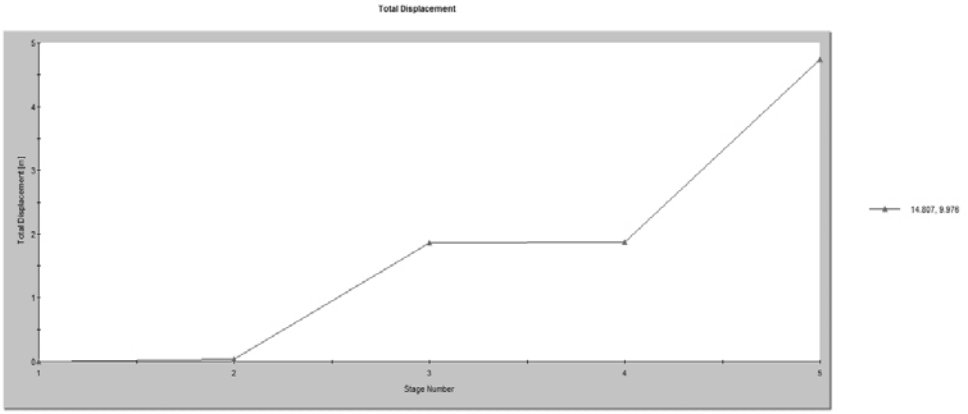
- Vertical and horizontal movements for stage 4:



- Vertical and horizontal movements for stage 5:



Movements in all five stages are given in the following graphic:



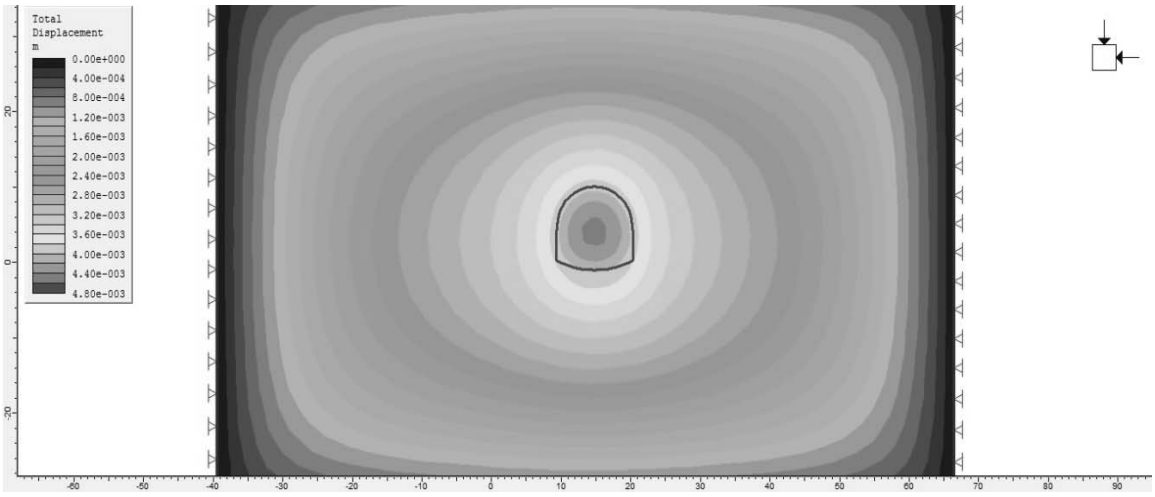
3. Advance with one free surface

Some as in case the excavation is done in two steps of execution was carried out and where the design is done by piercing shot with a free surface.

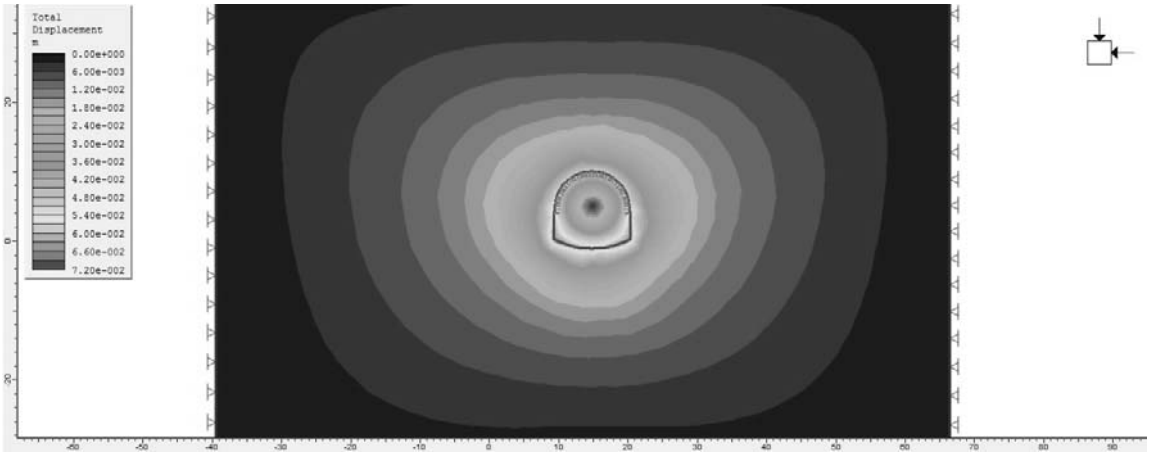
To finally make a comparison of two methods of advancing creates greater movement and higher tension into massive, if a single free surface, we conducted a Phase 2 modeling software (finite element modeling), to see how the massive behave and what displacements occur in this case. So, the way forward with smaller displacements and lower tension, will be the most appropriate from this point of view, because creating displacements on the outline of the work greater than allowed (red color), will affect the stability in terms of tunnel construction..

Thus, further, I present the results of horizontal and vertical displacements, obtained from modeling of tunnels that are believed to run with one free surface:

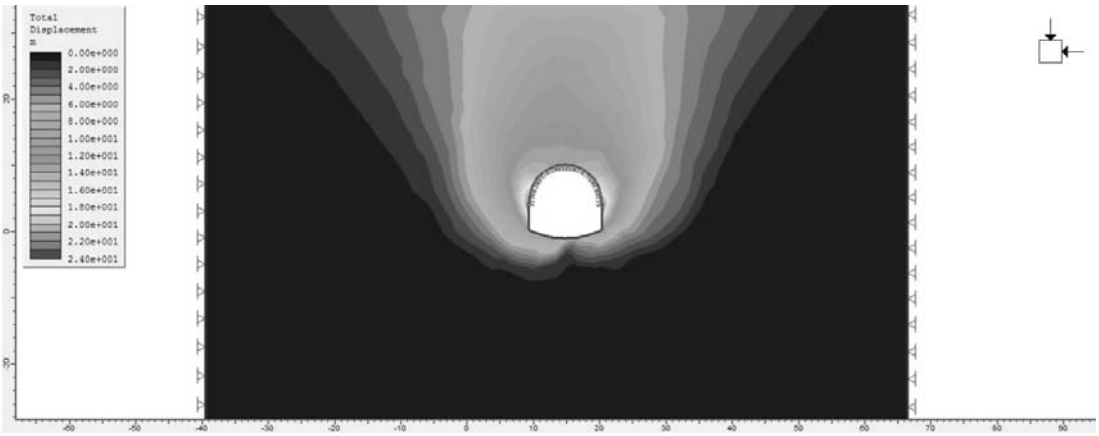
- Phase 1 of execution, massive is unaffected:



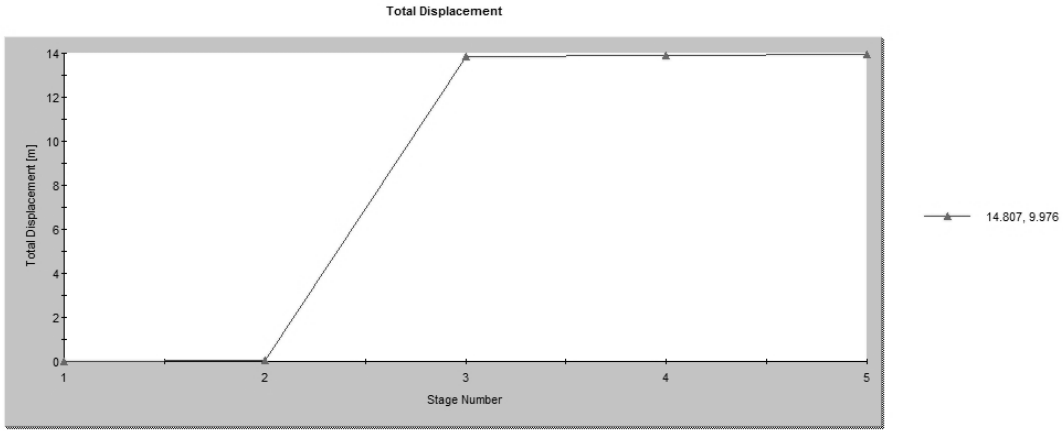
- Phase 2 of execution, excavation begins:



- Phase 3 of execution, excavation is completed:



Vertical and horizontal displacements are shown in the graph below:



4. Conclusions

Following implementation modeling with finite element by program Phase 2, can notice a considerable difference between the two methods of advancing with the perforation shooting.

The difference is that for digging in one step the movements are sudden and large, and to advance in two steps displacements are much smaller, so the risk of cracks in the massive is much lower in this case.

An particular importance is the type of rock and section work, but the results show that for not to be influenced the stability of work, the most appropriate is that the perforation shooting of tunnel to be done in two steps.

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