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FOUNDATION AND SOLIDITY SURVEY OF THE MONUMENT TRIANON CROSS ON THE SÁG HILL

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Abstract

In connection with the landscape architecture of the abandoned basalt quarry on the Ság hill, it was necessary to check the solidity and foundation conditions of the monument standing there.

The report expounds the results of the survey and makes proposals concerning the necessary tasks.

Keywords: rock engineering, foundation.

1. Introduction

Many questions arose as a result of the recultivation tasks in the Ság hill nature conservation area, that is the formation of the natural landscape created as a result of the former mining activity according to the environmental requirements of this age. The first and foremost of them, so to say, was the issue of the solidity of the monument.

The monument erected in 1933 on the crater rim of the basalt volcano monadnock is in a place of a quite varied geological structure. The basaltic tuff hillock supporting the nearly 20 metre high brick-lined pillar, containing the cross pointing towards Celldömölk, emerges from the cleared platform of the topmost quarry level.

The structure of the monument brick-lined with basaltic tuff blocks, narrowing towards the top, contains the concrete cross stretching over the brick-lined structure. The monument has a landscape forming role with its location and formation. Thus it is understandable that the evaluation of the situation was necessary from a geological and a structure solidity aspect, further justified by the fact that the former mining activity created a cave in the body of rock beneath the monument. As a result, the supporting wall built at the foot of the monument dislocated and was practically destroyed.

On the commission of Fertő-Hanság National Park, recultivation was performed by KKL Ltd. and its subcontractors. To this activity the Department of Engineering Geology of Budapest Technical University joined, performing the survey and evaluation of the rock surrounding the monument, as well as the foundation solidity calculations. Our special work included planning of the necessary and proposed intervention and the on site engineering direction of the construction work.

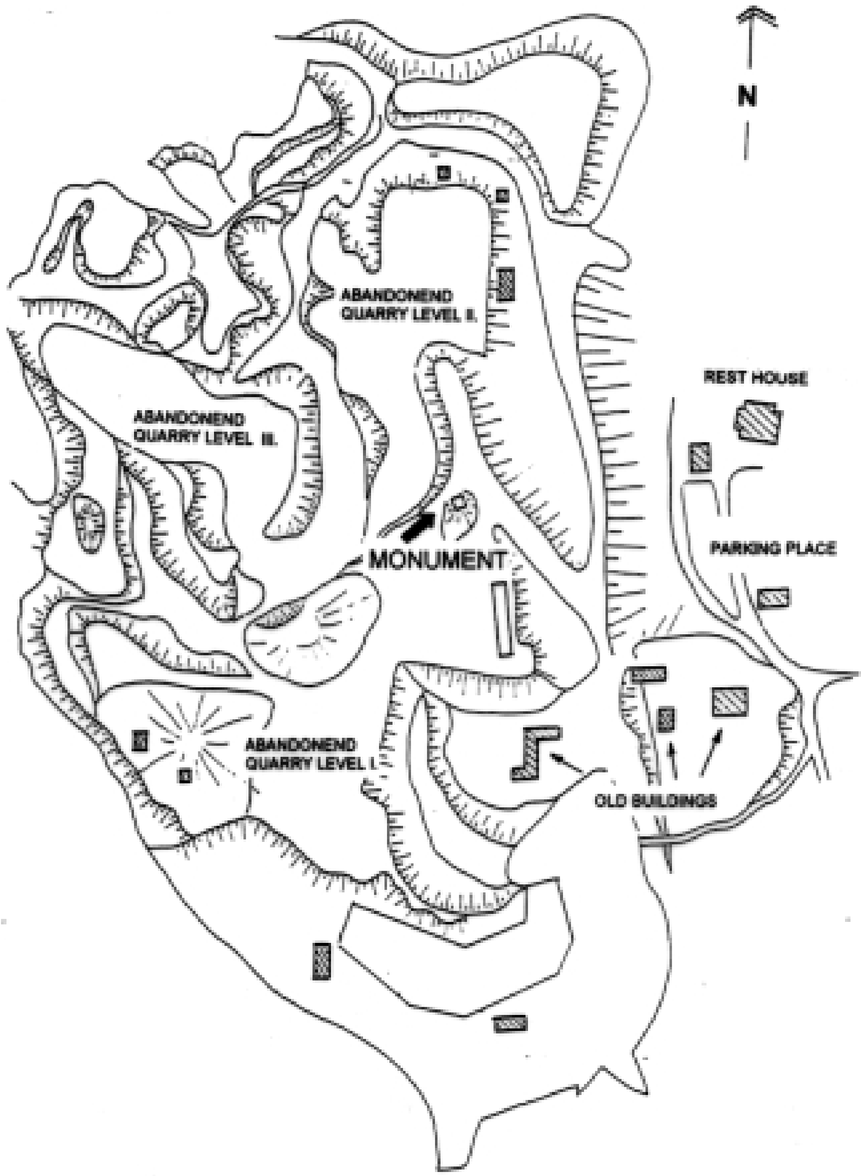

Fig. 1. ‘Trianon crucifix’ monument on the abandoned basalt quarry of the Ság hill

The foundation work performed in compacted surrounding rock may become interesting due to the fact that basic data necessary such for dimensioning and structure controlling that have to be determined in an area of a complicated geological structure are comparatively rarely met in Hungary, using the rules of the construction of engineering geological models. That is why our activity performed on Ság hill may be remarkable, the broader environment of which, that is the crater of the basalt volcano cut up by mining activity, is illustrated by *Fig. 1.*

2. The Rock Surrounding the Monument

According to our survey, the rock mass interacting with the monument as a structure is the block emerging as a single mass from the cleared topmost level of the quarry. From the aspect of technology, the rock material can be classified into two basic versions, namely:

- reddish brown and brownish grey basaltic tuffs with agglomerates or fine grains and b
- basalt with black fine grains.

The settlements of the two types of rock are characterised by similar geometrical dimensions. Both the reddish brown basaltic tuff and the overlaying basalt is inclined at an angle of 35–45° in the direction of NNW. The versions of basaltic tuff with agglomerates and fine grains are well layered. The rock generated in bulk is characterised by a bed-like jointing.

The majority of the rock mass under the monument is composed of basaltic tuff. The overlaying basalt in bulk is present on the W and SW side of the prosiliency corresponding to sloping conditions. Due to the steep inclination, there are parting and slipped basalt blocks seen on the W hillside.

Articulation surveys have been performed by an integral geometrical calculation of the specific values articulating surfaces. Varied geological structure is proved by the different degree of articulation of different bodies of rock. Results of the survey are contained in *Table 1.*

From the point of view of the monument basement, the characteristics of tuff bodies of rock can be regarded as standard. For their identification, we drew samples from the different varieties of rock for laboratory tests. Mass composition and solidity tests have been performed according to the series of test standards concerning building materials. Results determined for rock masses are summarised in *Table 2.*

From the results of survey, stress limits necessary for static and solidity calculations have been calculated from the average values and empirical scatter of survey results in accordance with our survey practice. The row of data represented in *Table 3* have been calculated from the limits thus specified for rock masses considering the discontinuity and using the relationship proposed by Protodyakonoff.

Table 1. Results of the jointing tests

Rock mass type	Density of the discontinuity t [m^2/m^3]
original basalt rock body	6.3
jointed basalt rock body discontinuity in view of the weather	45.0
ask comprises basalt tuff rock body	10.8
red-brown layered basalt tuff rock body	4.4
red-brown fine granule basalt tuff rock body discontinuity in view of the weather	10.8

3. The Foundation of the Monument

According to our registration, the monument was built in such a way that after clearing the rock surface, a levelling layer of concrete was applied and the building of the tower-like pillar, brick-lined with basalt blocks, was started on this levelled plateau. The foundation of the structure is the widening part of the pillar with dimensions 5.0 × 5.0 meters, at the SW corner of which the levelling can be well observed. *Figs 2* and *3* illustrate the structural formation of the monument.

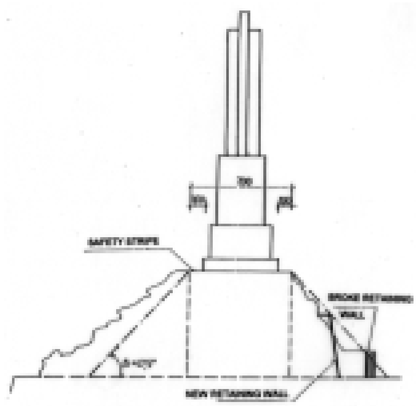

Fig. 2. Section $NE - SW$ with the angle of load (β)

Table 2. Laboratory mechanical properties of rocks

Rocky block	Bulk density kg/m^3	Apparent porosity V %	Compressive strength MPa	Modulus of elasticity MPa
basalt tuff (red-brown agglomerate)	1417	38.28	5.47	1420
basalt tuff (brown, fine)	1852	31.96	16.82	2690
basalt	2828	4.43	124.7	27810

Table 3. Mechanical properties of rock mass

Rock mass	Permissible stress working value MPa	Young's modulus $E_M = f(RQD)$ GPa
red-brown basalt tuff agglomerate rock body	0.64	1.0
brown, fine granule basalt tuff rock body	9.56	1.0
grey, jointed basalt rock body	15.34	6.0

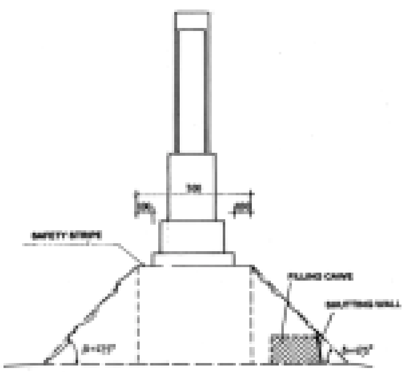

Fig. 3. Section $NNE - SSW$ with the angle of load (β)

Because of the erosion seen at the edges, when performing static controlling calculations, a surface of 4.6 m$\times$4.6 m was taken into consideration as the useful base surface providing for the actual load transmission.

Static calculations have been performed in accordance with the statutes of standard MSZ 15020 and using the load registration given in standard MSZ 25021.

The walling material of the monument with a brick-lined structure and the setting of its mortar could be classified into categories K50 and H4, respectively.

The eccentricity resulting from wind load is increased with uncertainty factors due to load transmission and the nature of the structure, registered depending on the slenderness (l_0/h_t) in accordance with the legal provisions concerning brick-lined structures (MSZ 15023).

According to our controlling calculations, results have shown that

– the load bearing capacity of the surrounding rock beneath the basement body is $n = 1.56$ at standard wind load,
– that of the brick-lined structure of the basement made from basaltic tuff blocks is $n = 1.76$,
– the solidity of the monument is $n = 1.92$

proved to be suitable with safety factors.

The limit angle of the load transmission is marked on *Figs 2* and *3*.

4. Results of the Survey

The experiences on site surveys and the results of the controlling calculations based on laboratory tests have proved that the monument built on the basalt and basaltic tuff rock mass standing in a single pillar, emerging from the topmost cleared level of the quarry can be treated only together with the recultivation of the area. We proposed the necessary tasks in accordance with this method of approach, namely:

– injection of the gaps between the surfaces of articulation on the basement surface, as well as the solution of water drainage outwards from the basement of the monument,
– backfilling of the cave beneath the monument reinforced with walls,
– prevention of erosion deterioration within or on the limit angles of load transmission by building new supporting walls in place of the old ones.

On the basis of construction plans designed according to our proposals, the necessary tasks, joining other landscape architecture activities, were completed in the summer of 1997.