ANALYSIS ON THE DEGRADATION STATE OF THE SITE OF CERTAIN RESIDENTIAL BUILDINGS

I. TUNS[1] **M. MÂNTULESCU**[1] **F. TĂMAŞ**[1]

Abstract: *The facts presented in the paper were generated by the implementation of a section of sewerage near and below the foundation level of a retaining wall with the role of maintaining the stability of several residential buildings.*

Key words: *retaining wall, horizontal displacement, degradation state, stability.*

1. Introduction

The area is located on the Eastern part of the town of Râşnov, on the national road towards Poiana Braşov next to the real estates no. 14 and 16 on Cetăţii Street.

The area is geologically included in the cretaceous orogenesis, of polimictic conglomerate nature, specific to the mountains in Poiana Braşov.

The street follows the axis of Cetăţii Valley, whose water is channelled through a system of reinforced concrete collector of ovoid form, placed under the road.

The slopes enclosing Cetăţii Valley have their bedrock the polimictic conglomerate Cenomanian, known as "the conglomerate in Bucegi" over which a layer of deluvial - proluvial alteration was couched.

The studied site consist in an artificial platform that passes over the rocky slope towards South, and on the Northern side is limited by the retaining wall located on a sandy and dusty diluvium, of a width of about (50-70) cm, Figure 1.

The investigations carried out have not revealed the presence of underground water, the surface water being collected and directed to the sewerage network.

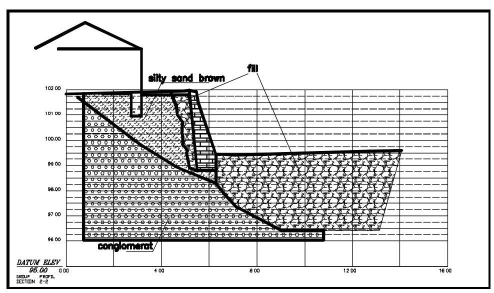

Fig. 1. *Soil geotechnical profile*

From a geomorphologic point of view the site belongs to a valley known as Cetăţii Valley that crosses over the Mountains of Poiana Braşov from the central to the Western area, being a right affluent of Bârsa.

Given these forming conditions, the river bed is dug in conglomerates, and on the slopes being couched a diluvium cover, mainly sandy.

The General plan of the analyzed site is presented in Figure 2.

[1] Civil Engineering Dept., *Transilvania* University of Braşov.

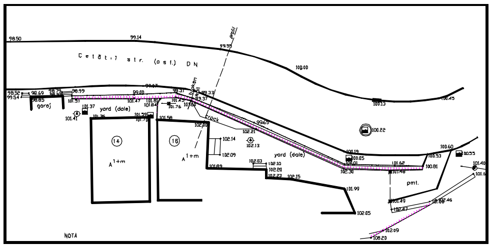

Fig. 2. *The general plan*

2. The Analysis of Degradation State

2.1. Causes and Manifestation Forms

The platform artificially created having the role of support layer for the buildings mentioned under the previous point is limited on the North side by a retaining wall made of stone masonry to ensure stability of the soil located behind it.

Sewage works carried out near and under the wall lead altered the strength and stability of a section of the wall and of the related soil.

The degradation degree was determined mainly by the work of excavation carried out without protective measures on a relatively large length, and under the foundation level of the wall and left open a certain period of time.

The degradation degree [1] was thus accelerated by also other disturbance factors, such as:

• breakage during excavation works of a water pipeline placed at a depth of approx. 0.80 m, at a distance of approximately 1.0 m from the wall;

• removal from a balanced position of a section of the retaining wall, by registering linear and angular displacements as a result of annulling the effect of reactive pressure of the excavated soil from the front of the wall being in contact with it before the excavation works, the lack of soles, as well as the reduced embedment length of the wall in the soil;

• the break off of stones from the wall, sections with deep cracks, exfoliations of material structure due to the long degradation of the environmental factors;

• increase of aggressive factors due to vibrations caused by movement of road vehicles.

Investigations carried out on the spot have spotlighted the following manifestation forms of degradation state:

• the large opening of the settlement joint at the same time with several horizontal displacements of the exterior sides of the two adjacent sections of wall, Figure 3;

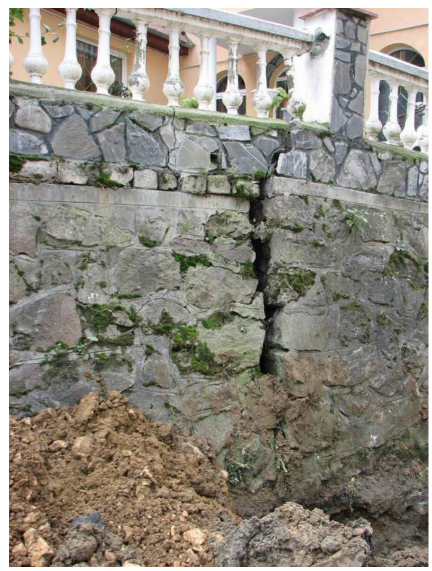

Fig. 3. *The large opening of the settlement joint*

• degradation of the upper wall and of the bulwark of protection, by spotting several large opening cracks, uniformly distributed, with horizontal and vertical displacements of the their bordered parts, Figure 4;

• breaking off of several sections of wall masonry at the same time with the crash of the soil behind it, Figure 5;

• linear and angular displacements of the retaining wall and the formation of massive deep caverns in the ground behind it, Figure 6;

Fig. 4. *Degradation of upper wall area and of the protection bulwark*

Fig. 5. *Break off section of the masonry wall and the crash of the ground behind*

Fig. 6. *Formation of massive caverns behind the retaining wall*

• the infiltrations of water into the ground due to the lack of tightness of the pluvial sewage for the surface waters located in the yard of building no. 14, Figure 7;

Fig. 7. *Water infiltrations from the pluvial sewage*

• the continuing action of the environmental factors has fully contributed to enhancing the state of degradation by the presence of cracks in the stone block, exfoliation of joint plaster, breaking off of stone blocks from the wall, vegetation growth, Figure 8.

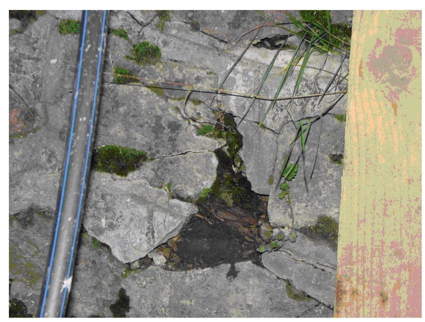

Fig. 8. *Wall section with wide cracks, break off of stone masonry and vegetation growth*

2.2. Effort States and Strains of the Bulk Ground

In order to restore the capacity for strength and stability of damaged retaining wall and of the bulk ground behind it, following the state of degradation spotted, thereby endangering the strength and stability condition of buildings bearing the numbers 14 and 16, the analysis of efforts state and horizontal strains in bulk grounds was carried out. For the computation of the ground the software GeoStudio by module SIGMA/W [2] was used.

Land shaping, Figure 9, was carried using 4 types of materials:

a) basic rock - conglomerate, with dimensional stability properties of a solid;

b) the front and the back filling of the wall, considered as a linear elastic material with the deformation modulus $E = 5000$ kPa;

c) diluvium sand dust, with $E = 10000$ kPa;

d) the retaining wall, considered by disparate elements by the average cohesion value, $c = 100$ kPa.

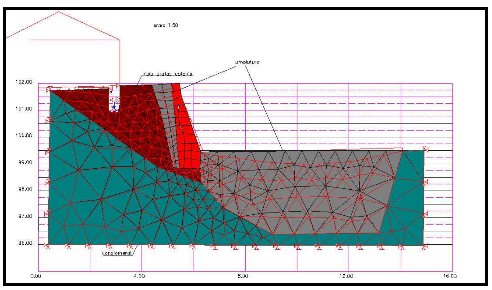

Fig. 9. *Discretization of the bulk ground*

The analysis of effort state and horizontal displacement was carried out in three stages:

1. initial stage of incident occurrence;
2. execution stage of the excavation in view of performing the new wall next to the existing one;
3. the stage of removing the retaining points after ground excavation of the existing wall.

The three stages of analysis have resulted from technological point of view, such as:

• during the initial stage the evaluation of the foundation level degree of the buildings was carried out - buildings nearby, in order to identify the optimal solution for rehabilitation;

• the second stage aimed at assessing the opportunity to adopt the solution of rehabilitation required by the beneficiary, by carrying out the new retaining wall in front of the existing one;

• the third stage was aimed at assessing the site degree of stability during the critical stage of work, with the excavation of ground from the old wall and removal of retaining points.

For the computation it was considered that the overload of the foundation sole of the building is 300 kPa, and earth displacements are limited on the profile.

By analyzing the state of efforts and horizontal strains of the ground considering the three work stages it resulted that:

• **In the initial stage 1** the unitary horizontal efforts considerably increase in the area next to the neighbouring building foundation, Figure 10, without this, however, being affected, and the maximum horizontal displacement of the bulk land reaches 3.2 mm, Figure 11.

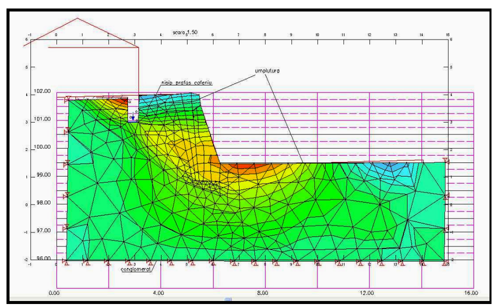

Fig. 10. *Distribution of horizontal efforts in the ground next to the neighbouring building at the initial stage*

• **In the second stage** it was ascertained the accumulation of horizontal efforts at the basis of the wall, where the maximum horizontal displacement is recorded, namely 6.4 mm, Figures 12 and 13;

• **In stage 3** it was noticed that the effort state does not change significantly in the building foundation area, Figure 14 and the maximum horizontal displacements of the basis of the wall increased to 10.2 mm,

Figure 15, but they do not constitute a dangerous burden for adjacent buildings.

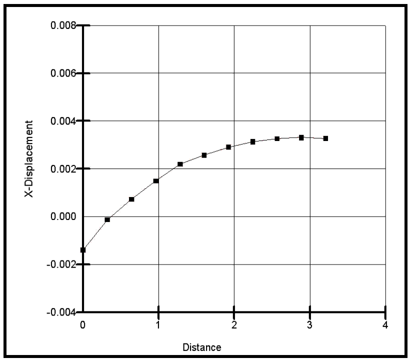

Fig. 11. *The chart of horizontal displacements of the ground of the inner side of the wall*

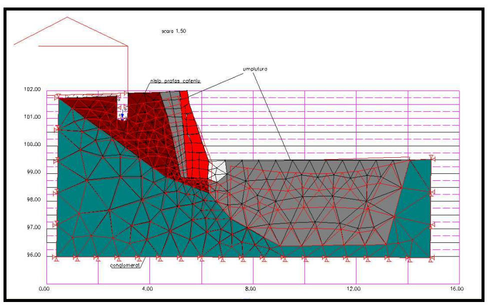

Fig. 12. *Distribution of horizontal efforts in the ground next to the neighbouring building at the initial stage*

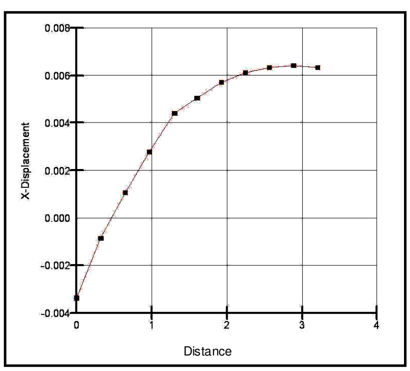

Fig. 13. *The chart of horizontal displacement of the joint network points on the inner side of the wall*

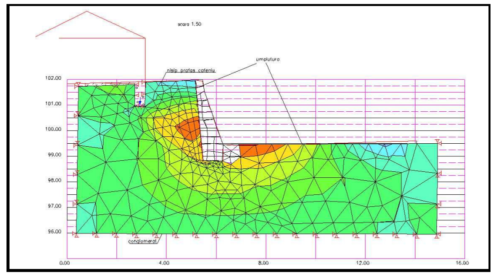

Fig. 14. *Chart of unitary horizontal efforts in work stage 3*

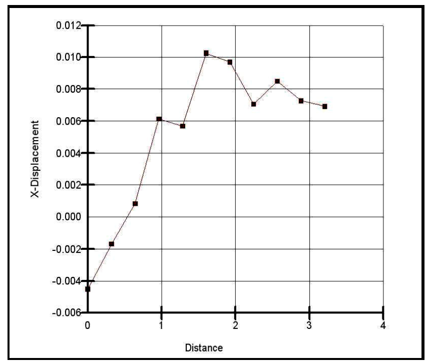

Fig. 15. *The chart of unitary horizontal efforts in work stage 3*

3. Conclusions

The major displacements of the retaining wall affected by the drainage works have determined the break off by crash of portions of the wall by affecting the ground behind, thereby endangering the stability and strength of the two buildings located in the neighbourhood.

The analysis of state of efforts and horizontal displacements of the ground in the three work stages enabled the adoption of the site rehabilitation solution by:

- building a retaining wall of reinforced concrete from the existing one [4];
- restoration of the mechanical characteristics of the land affected by the filling with compacted material and injection of adios material.

The proposed rehabilitation solution

ensures the restoration of strength capacity and stability of the damaged site without affecting the safe operation of existing buildings [3], [5].

The foundation of the new wall was carried out on the layer of yellow sand dust with rare gravels, having the acceptable pressure *Pacc* = 310 kPa at a depth of −1.60 m, compared to road level.

Fig. 16. *Temporary blocking the basis and supporting the wall*

To temporary restore the situation caused after the execution of sewerage works, it was proposed and also applied the blocking of displacement of wall basis by filling the excavation with a concrete of class C5/7.5 and by temporally supporting the wall, Figure 16.

The results obtained from the analysis of efforts state and strains accounted for the departure elements when calculating the size of the retaining wall of reinforced concrete located in front of the damaged one, operation that was performed during the second work stage (design of the new retaining wall).

References

1. Budescu, M., Ciongradi, I.P., et al.: *Consolidarea Construcţiilor* (*Construction Reinforcing*). Iaşi. Vesper Publishing House, 2001.
2. Krahn, J.: *Stress and Deformation Modeling with SIGMA/W - User Manual.* Geo-Slope Ldt., Calgary, Alberta, Canada, p. 412.
3. Stanciu, A., Lungu, I.: *Fundaţii. Vol. I* (*Foundations. Vol. I*). Bucharest. Technical Publishing House, 2006.
4. Tuns, I.: *Calculul şi alcătuirea fundaţiilor* (*Computation and Foundations*). Braşov. Publishing House of the Transylvania University in Braşov, 2004.
5. Tuns, I., Mântulescu, M.: *Aspecte privind realizarea unei fundaţii tehnologice de dimensiuni mari în apropierea şi sub cota fundaţiilor structurale existente* (*Aspects Regarding Executation of Technological Large Foundation Near and Under Existent Structural Quota Foundations*). In: The XI-th Geotechnical and Foundations National Conference, Timişoara, Politehnica Timişoara Publishing House, 18-20 September 2008, p. 384-391.