CONSIDERATIONS REGARDING THE STABILITY OF TOPOGRAPHIC LANDMARKS PLACED ON A SALT PROBES FIELD

PH.D Raluca Farcaş [1], Prof. Dr. ing Nicolae Dima[2], Lect. dr. ing. Sanda Naş[3], Asist. Lect. dr. Andra Poruţiu[4],
[1,2] Universitatea din Petroşani, Romania
[3] Universitatea Tehnică Cluj-Napoca, Romania
[4] Universitatea de Stiinte Agricole şi Medicina Veterinara – Cluj-Napoca, Romania

Abstract: *The goal of time tracking constructions placed on a salt probes field is to obtain information in order to ensure the construction stability and to obtain an evaluation of the environmental conditions in order to prevent certain natural accidents, respectively prevention through diminishing material damages, prevention of loss of life and of environmental degradation.*

Based on topographic measurements conducted on topographic landmarks placed in the field or on topographic marks placed on the constructions' foundations is tracked the determination of deformations and displacements that occur in the salt exploitation influence area and are also tracked the displacement directions of the landmarks (vertical displacements).

Keywords: *stability, deformations, topographic landmarks, salt exploitation, displacements.*

1. Introduction

The purpose of the study is the instability phenomena forecasting the evolution of the mining site Gura Slănic and determine their influence on surface area and existing buildings (buildings, networks, bridges) and developing the necessary measures to mitigate the effects of the instability phenomena.

Location of facilities in areas of influence of mining is done only in cases absolutely necessary, applying measures consisting of:

- avoiding adverse change to the water regime;
- capture, drainage, sewage, regulating watercourses;
- avoid water accumulation through the implementation of "dams";
- 50-100-300 m deep drillings, executed in the areas of influence are cemented, by this measure avoiding the intrusion of water in the salt massive;
- ongoing monitoring of the influence area and existing buildings in order to detect the early stage of any deformation of the land and construction.

Because regarding salt mines, there isn't legislation to specify, depending on the type of construction, the maximum allowed dives and displacements, according to literature

and observations from different salt basins, including Gura Slănic, it can be stayed that in areas affected by the exploitation, land movements are:

- movements due to the imbalance caused by the exploitation, without the modifying action of possible dissolution phenomena on the back of salt, exhibiting phases of:
  - acceleration;
  - constant speed;
  - extinguishing.
- movements due to the imbalance caused by the exploitation, over which it over lapses the modifying effect of the dissolution on the back of the salt, exhibiting phases of :
  - acceleration;
  - dissolution of floors slabs and pillars;
  - subsidence.

Norms and standards in construction (NP-055-2001 on seismic design of housing construction, social-cultural, industrial and agricultural buildings, STAS 1242/61) regulates the design of new buildings and presents principles for assessing the level of protection of the existing buildings, and determines the potential intervention measures in emergency situations.

Târgu Ocna locality is in the seismic zone C. Because of this seismic zone classification and according to STAS 1242/61 that prohibits placement of constructions in areas where there are gaps underground and also because of dives that are recorded here, it is recommended the removal from the GUP of the lands associated with the exploitation perimeter Gura Slănic - Târgu Ocna.

2. Materials and methods

The aim of topographic works is to monitor the instability phenomena manifested on the surface of land adjacent to the salt exploitation from Gura Slănic by topographic surveying completed in time.

Topographic monitoring involves conducting measurements and their analysis and interpretation. The monitoring points are coded and materialized in the field through terminals, landmarks and topographic marks placed in the foundations of buildings, having established topographic coordinates.

Topographical level measurements were executed using level LEICA DNA 03 and invar laths with bar code, according to specific methodology for middle geometric leveling. For conducting measuring, indirect measurement method was adopted.

Precision topographic measurements conducted on time tracking marks, have an important role in the concept of tracking (surveillance) of land surface deformations and stability of Gura Slănic probes field.

For calculating the elevations of all milestones in the probes field from Gura Slănic was used the starting elevation of the reference landmark RN (DTM) 1940 from the railway station building in Târgu Ocna.

To determine the vertical displacements of tracking benchmarks, level measurements were performed to obtain elevation (z) for each item.

Vertical movement represents the level change of that area in relation to the initial level of the same area.

It is a parameter that can be determined directly by level topographic surveying.

Vertical displacement (ΔZ) is determined by the difference between the elevation from the current measurement and the elevation from the previous measurement (immersion during period **ΔS)** or primary measurement (total immersion S).

3. Analysis of the results of level measurements registered by topographic marks placed in the foundations of the constructions in the probes field

Results of processing leveling measurements performed on topographic marks are shown in the following table:

Table 1. Level measurements registered by topographic marks

Landmark Name	ΔS [mm] 2009-2010	ΔS [mm] 2010-2011	ΔS [mm] 2011-2012	ΔS [mm] 2012-2013	ΔS [mm] 2013-2014
P1	-11.4	4.3	-4.3	-4.9	-0.3
P2	-7.5	-12.7	8.4	-13.4	-7.9
P3	-4.9	-3.1	-4.4	-4.9	-5.3
P4	-8.5	-6.2	-7.6	-10.4	-10.2
P5	-10.4	-8.7	-8.7	-11.3	-11.5
P6	-13.6	-6.0	-9.8	-11.7	-12.7
P7	-6.3	-7.9	-10.7	-14.5	-11.4
P8	-4.1	1.1	3.5	-8.2	-6.4
P9					0.0
P10	-1.9	-2. 3	-0.4	-7.2	-7.8
P11		-1.7	-1.2	-6.6	-8.0
P12		-0.9	-1.9	-8.7	-7.4
P13	-6.0	-2.1	0.4	-7.8	-8.3
P14		-1.8	8.1	-7.6	-9.5
P15	-1.0	-1.5	3.8	2.1	-15.1
P16	-1.7	-0.9	4.8	3.3	-14.2
P17	-1.5	-1.4	3.7	4.5	-22.2
P18	-1.2	-1.7	4.1	3.8	-14.2
P19	0.0				0.0
P20	-7.3	-10.9	-3.2	6.0	-7.7
P21	-5.9	-1.2	0.9	-7.7	-6.5

ΔS [mm] – Immersion on period

In the construction area, values of immersion for the period 2010-2011 recorded by the landmarks are between [-10.9 ÷ 4.3 mm].

In the period 2011-2012, the stability tracking landmarks registered immersion values between [-10.7 ÷ 8.4 mm].

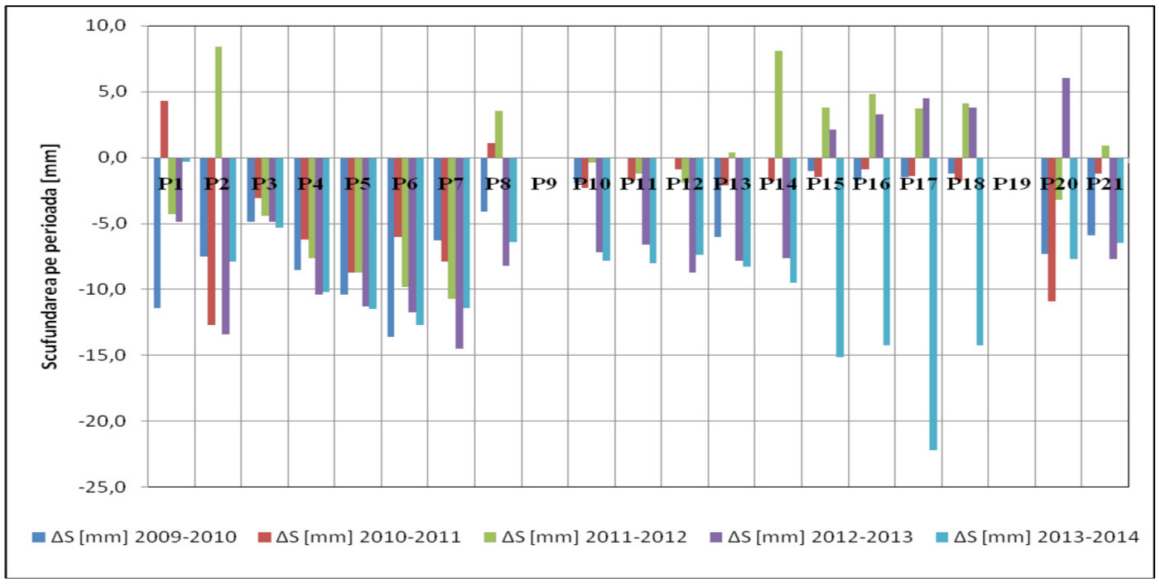
In the period 2012-2013, the stability tracking landmarks registered immersion values between [-14.5 ÷ 6.0 mm].

During 2013-2014, the stability tracking landmarks registered immersion values between [-22.2 ÷ 0 mm].

In the analyzed area, during 2013-2014, all tracking landmarks registered negative values for immersion on period.

In the variation diagrams it can be seen each landmark's development in terms of immersion on period recorded during a certain measurement (Fig. 1).

Based on planimetric coordinates and on immersion values during 2013-2014, were represented izoimmersions (equal immersion curves) on this leveling route and they are



shown in Fig. 2.

Fig.1. Variation Diagram of Immersion on Period

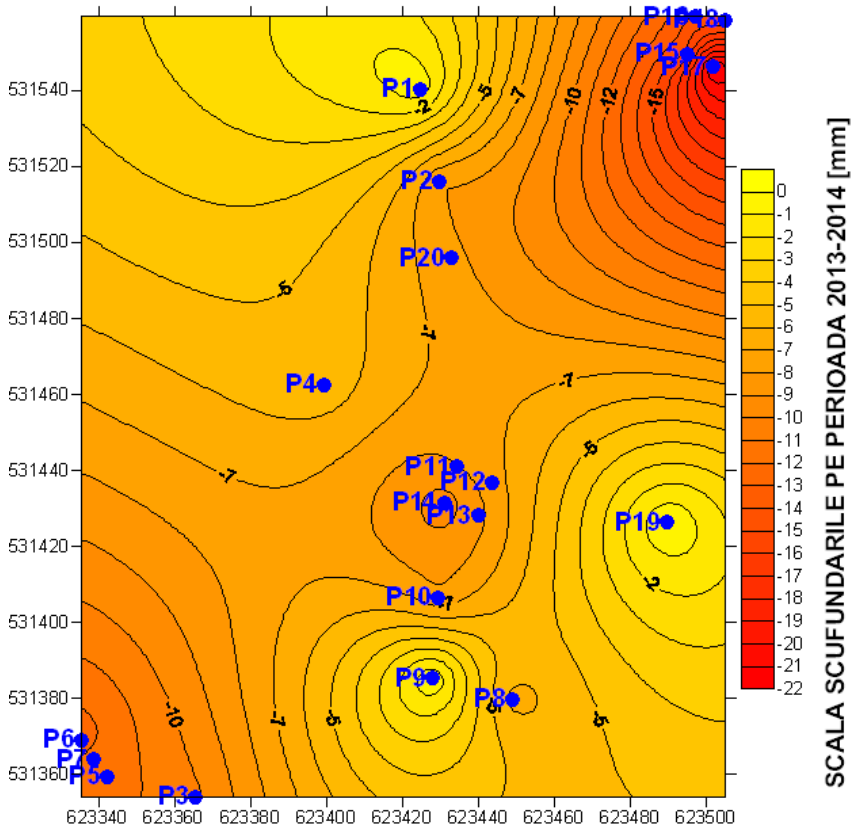


Fig. 2. Curves of Equal Immersion during 2013-2014

Fig. 2 is read using the scale of immersion for the period 2013-2014 (shades of color), where are highlighted in yellow positive values representing land liftings and in red negative values representing land immersions, values given in mm.[4]

4. **Conclusions**

The results of measurements in 2014 at topographic marks placed in the foundations of buildings indicate that they are constantly moving vertically.

Topographic-geodetic methods through high precision measurements made and by the modalities of collecting data and estimation of results is a basic system in the extensive process of studying the behavior of construction.

Within topographic tracking monitoring of the constructions, it will be given particular attention to:

- Vertical movements registered by level landmarks from the construction area or topographic marks area.
- Surface modification that may occur due to the action of natural and anthropogenic environmental factors in the area tracked.

The land under constructions influences their structural resistance frame through foundations, causing in them additional efforts and deformations. The size of the efforts and deformation of the resistance structure is dictated mainly by the magnitude of movements and not by the unevenness of these movements (lifting-lowering etc.) registered at the contact point between the foundation and the ground.

The determination and referral in time of the occurrence of strains and displacements has particular importance regarding the safety of a building, while a misinterpretation of the results of observations could cause quite serious situations.

5. **Refferences**

[1] Ciotlăuş A., Giurgiu N., Ortelecan M., Marina O., Tracking the Stability of Mining Works by Topographic Measurements at Slănic Prahova Saltmine, Rev CAD - Cadastre Magazine University "1 December 1918" Alba Iulia.

[2] Dima, N. & Pădure I., Herbei, O., Mining Topography, Publishing House Corvin,1996, Deva.

[3] Vereş I. & Fărcaş R., Ştefan N., Study on the Surface Instability of the Coal Exploitation Area in Livezeni, SGEM 2013, Conference Proceedings, Bulgaria, June 16-22, 2013, Vol. 2, 427-434 pp.

[4] Vereş I. & Fărcaş R., Ştefan N., The Topographic Monitoring of the Terrain Damaged by the Exploitation of Salt in Ocna Mureş, Romania, SGEM 2014 Conference Proceedings, June 19-25, 2014, Vol. 2, pp 583-590.