ASPECTS CONCERNING THE BEHAVIOUR OF BUILDINGS DURING TIME

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Abstract. Monitoring the way constructions behave over time is a corollary of the construction activity, constituting an obligation of the builder in relation to the works he has carried out and has been practiced, in various forms, since the beginning of construction. This paper presents aspects and manifestations that appeared in the process of monitoring a construction that was "disadvantaged" from the start due to the nature of the foundation land.

Keywords: construction montoring, topographical methods.

INTRODUCTION

The construction monitoring activity accompanied the construction activity over time, being carried out, even when there was no specific legislative framework, based on the customs and experiences passed down from generation to generation. In the famous code of King Hammurabi, the liability of the builder towards the beneficiary is specified in five articles (Georgescu, 2020).

The legislation and specialized regulations in force provide, with rare exceptions, the obligation of the current monitoring activity for all types of constructions, regardless of their category, importance class and form of ownership, and also an obligation for special monitoring, carried out on the basis of a special monitoring project, in the case of new constructions that have provided for this monitoring category by design, or in the case of constructions in use for which this monitoring category was imposed based on a technical expertise or an extended inspection (Regulation P130, 1999).

Since 2012, in the Romanian Classification of Occupations (RCO) there are three professions strictly related to the activity of monitoring the behaviour over time, namely: technical manager for the current monitoring of the behaviour of constructions, specialist in monitoring the behaviour of constructions and expert in monitoring the behaviour of constructions.

In the monitoring activity, topographical methods are common, being applied both in the phase of experimental studies on scale models of the constructions and, especially, in the phase of their execution and exploitation, given the high precision with which the absolute values of displacements/deformations of the construction or its structural elements are determined.

Currently, complex monitoring technologies are increasingly being used, through which devices installed on the monitored objective automatically and permanently collect data on the behaviour of the construction, and transmit them, in real time, to groups of specialists (Coşarcă, 2011; Rădulescu et. al., 2017).

MATERIAL AND METHOD

The studied construction is located on a difficult foundation ground. Until the 7^{th}-8^{th} decades of the last century, the land was occupied by a lake (Arsene et al., 2015) (Fig. 1).

Fig. 1 The status of the area where the construction was located until the 7^{th}-8^{th} decades of the 20^{th} century

After draining the lake and depositing construction waste, a park was set up on the resulting land, and later a part of the land was assigned by the public authorities in order to build the adjacent building.

The current configuration of the construction was obtained in three stages. Although the constructive solution adopted was in accordance with the conclusions of the geotechnical studies carried out (Arsene et al., 2017), there were problems of differential settlement, mainly of the floor but also of seven of the pillars of the resistance structure, since the first stage of exploitation of the construction (Arsene, 2023).

a. *b*.

Fig. 2 Cutting out the floor for reprofiling

The process of differential settlement of the floor required the making of some cutouts of it next to the central pillars of the resistance structure (areas where the floor has minimal settlements) and periodic reprofiling works, to ensure the horizontal plane of the floor, necessary for the operation of the production lines (Fig. 2).

According to the monitoring program underwent, to establish the values of the vertical displacements of the pillars and the floor, quarterly measurements were made by precise geometric leveling with a KoNi 007 type level and mire with invar band.

The differential settlement in the case of the pillars produced irregularities regarding the slope of the cover panels. To determine the slopes along the row of pillars, measurements were made to establish the height at the base of the pillars, their size and the distances between the pillars; the determination of the height at the base of the pillars was carried out under the same conditions as those for establishing vertical displacements, and a laser distomate was used to measure the size of the pillars and the distance between them, with reflective targets fixed to the upper part of the pillars (Fig. 3).

a. *b.*

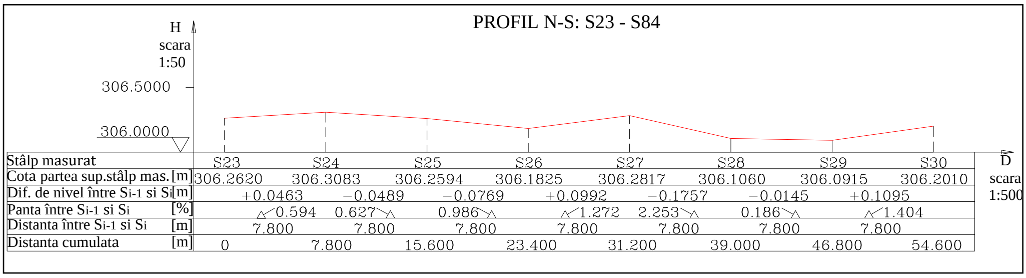
Fig. 3 Fixing reflective targets

RESULTS AND DISCUSSIONS

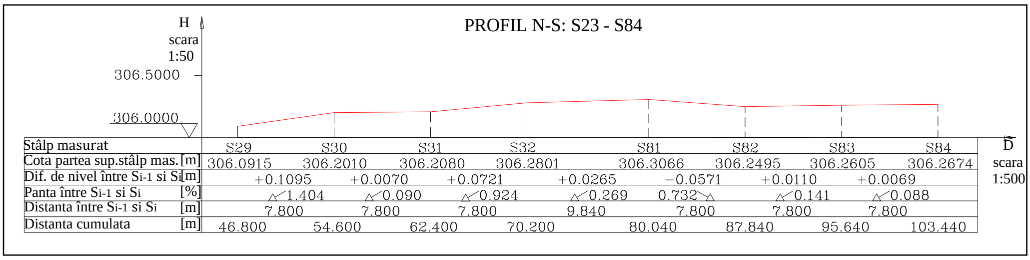
The results obtained show that the differential settlement of the pillars during the exploitation period determined the modification of the geometry of the structure. The longitudinal N-S profile made for the row of central pillars S23-S84 clearly indicates the discontinuity zones caused by the differential settlement of the pillars: S25, S26, S28, S29, S30, S31 and S82. The profile represents the situation at the top of the pillars, to indicate how the cover's geometry has been affected, but the situation is similar at the base of the pillars.

To be able to fit it in the page, in Fig. 4 the profile was divided into two: from pillar S23 to pillar S30 (Fig. 4.*a*.) and from pillar S29 to pillar S84 (Fig. 4.*b*.) (with a continuity zone S29-S30 between the two sides).

The highest settlement values are recorded by pillars S28 and S29. The two pillars recorded higher settlement values from the beginning. Over time, the periodic settlement values of pillar S29 decreased, while the rate of settlement of pillar S28 remained almost constant at the value of 1mm/month.



a.



b.

Fig. 4 Longitudinal profile S23 – S84

In order to not affect the resistance structure by the occurence of additional loads in the beams, a decade ago the pillar was raised, by adding a metal piece at the base, by 160mm. By continuing the settlement process at the same speed, the pillar S28 is currently almost 5cm higher than its pre-lift position, settling 111mm in 120 months.

After a one month interval from the date of determining the height at the base and at the top of the pillars in the office constructed with the light structure around the pillars S30 and S31 it was damaged in the NW corner by destroying the ceiling and breaking the glass in the corner (Fig. 5).

Fig. 5 The damaged NW corner

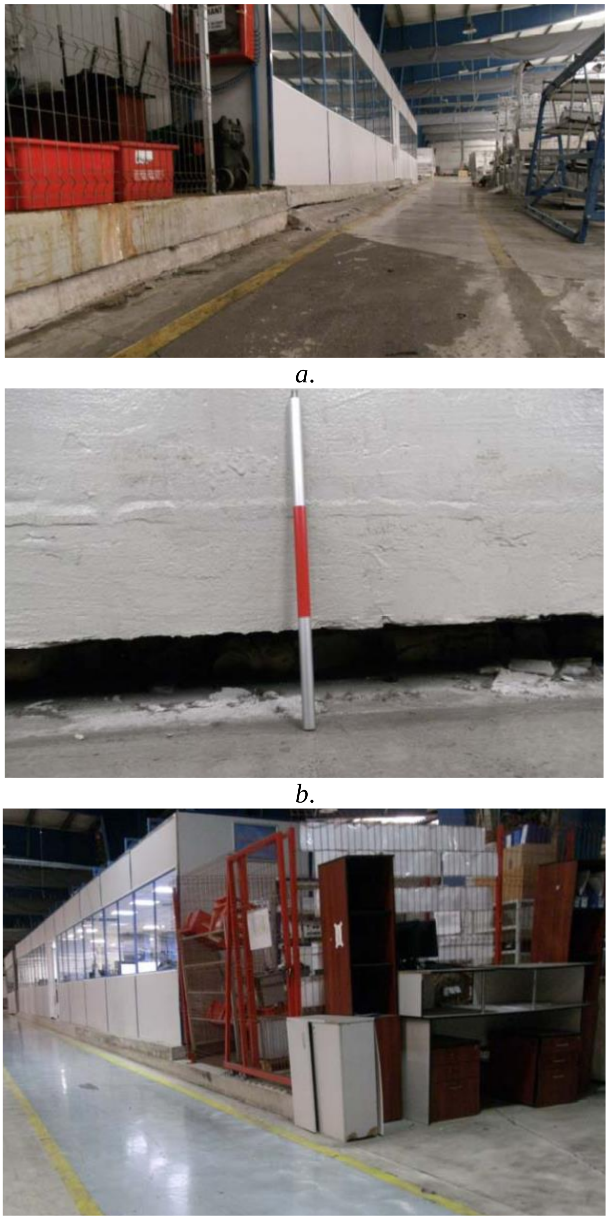
At the same time, a crack appeared in the floor with an opening of 7÷10 mm along the entire length of the office (Fig. 6).

Fig. 6 Crack in the office floor

Table 1

Crt. No.	Name of the measured pillar	Measurement		Settlement against:
		initial: 19.01.2024	current: 27.02.2024	
		Height at the base of the pillar [m]	Height at the base of the pillar [m]	initial measurement [mm]
1	F2 -reference	300.0000		
2	S115*	300.1281	300.1284	0.3
3	S23	300.0780	300.0784	0.4
4	S24	300.1273	300.1275	0.2
5	S25	300.0754	300.0751	-0.3
6	S26	300.0005	300.0000	-0.5
7	S27	300.1037	300.1033	-0.4
8	S28**	299.9200	299.9188	-1.2
9	S29	299.9095	299.9091	-0.4
10	S30	300.0200	300.0200	0.0
11	S31	300.0240	300.0240	0.0
12	S32	300.0981	300.0985	0.4
13	S81	300.1176	300.1180	0.4
14	S82	300.0995	300.1000	0.5
15	S83	300.1115	300.1111	-0.4
16	S84	300.1164	300.1160	-0.4
17	S314*	300.1169	300.1170	0.1

The determinations made (Table 1) show that in the interval between the two measurements, the settlement of the pillars did not exceed 0.5mm, except for pillar S28 whose settlement was 1.2 mm.



a.

b.

c.

Fig.7

The settlement of pillars S30 and S31 in the damaged area is null. Therefore, it was not the vertical movement of the pillars that moved the floor. The the cutouts of the floor next to the central pillars were done symmetrically in relation to the pillars (Fig. 2). When the office was built, the surface resulting from the cutout (whose height was at the level of the pillars) was extended only on the west side by approx. 1.5 m.

As the process of differential settlement of the floor continued, on the east side of the office, at the junction between the lower part of the office floor and the floor of the production space, a fracture line appeared caused by the pronounced settlement of the floor of the production space in relation to the office floor (Fig. 7 *a*., *b*.); on the west side (Fig. 7 *c*.) the sttlement of the floor in the production space occurred in solidarity with the extended portion of the office floor.

Thus, if on the east side in the interval October 2019 - February 2024 the settlement of the lower part of the office floor was of -41mm in the NE corner, respectively of -73mm in the SE corner, on the west side the settlement of the lower part of the office floor (in same interval) was of -148mm in the NW corner, respectively of -161 mm in the SW corner.

The imbalance between the settlement type on the two sides of the office caused the floor on the west side of the office to fracture along the boundary between the original portion and the extended portion, which led to the destruction of the ceiling and the breaking of the glass in the NW corner of the office.

CONCLUSIONS

The construction monitoring activity is a corollary of the construction activity and derives from the stability and durability requirements that any construction must satisfy, as well as from the requirement to function safely throughout the entire exploitation period.

Topographical methods are currently used in the activity of monitoring the behaviour over time because, based on the observations made, they provide certain information to establish: the state of the construction at that time and whether the response it provides to the demands to which it is subjected is in accordance with the projected situation. At the same time, the obtained data make it possible to model the "in situ" behaviour of the monitored objective.

The analysis of the settlement process in the presented case shows that the land on which the construction was built, obtained as a result the draining the lake and depositing construction waste, is a system with a heterogeneous structure. The layers in the composition of this system have a high humidity, the underground water level being of 0.8-0.9m above the surface and therefore the degree of consolidation is reduced. As long as the heterogeneous system is <closed>, a state of relative equilibrium is established.

The execution of works for the construction of new buildings near the studied construction leads to the immediate disturbance of the state of relative equilibrium. Under the pressure exerted by the studied building and the other constructions already built, the underground water contained in the system "invades" the new pits of the foundations, being then forcibly evacuated, and the hydrological balance is disturbed. The effects of the disturbance are reflected in how settlement occurs.

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