STUDY OF THE EFFECTS OF A HIGH EARTH EMBANKMENT ON A NEARBY BUILDT-UP LAND

Prada Marcela*, Tudor Dan**

*University of Oradea, Faculty of Construction, 4 B.St.Delavrancea St., 410048 Oradea, Romania, e-mail: mprada@uoradea.ro
**University Politehnica Timisoara, Faculty of Construction, 2 Tr. Lalescu St., Timisoara, Romania, e-mail: dan.tudor@ct.upt.ro

Abstract

At the present time, increasingly, structural engineers face with situations that are required to perform construction in close proximity to an existing building. This paper describes the effects on A.N.A.R.Z. – Bodrogului Way.No 3 construction, Arad, Romania, following the failure of the subsoil in the area adjoining slope Arad-Timisoara highway overpass over Bodrogului Route in Arad. We studied the behavior in time of the existing building by topographic measurements, resulting in aggravation of initially damages in structural and non-structural elements, with serious consequences for local resilience and stability of the building. Therefore, it is recommended to avoid similar situations.

Key words: slope, damage, behavior, stability, consolidation, risk.

INTRODUCTION

Increasingly the question to achieve highways and their passages, not infrequently structural engineers face situations where their route is adjacent to existing buildings.

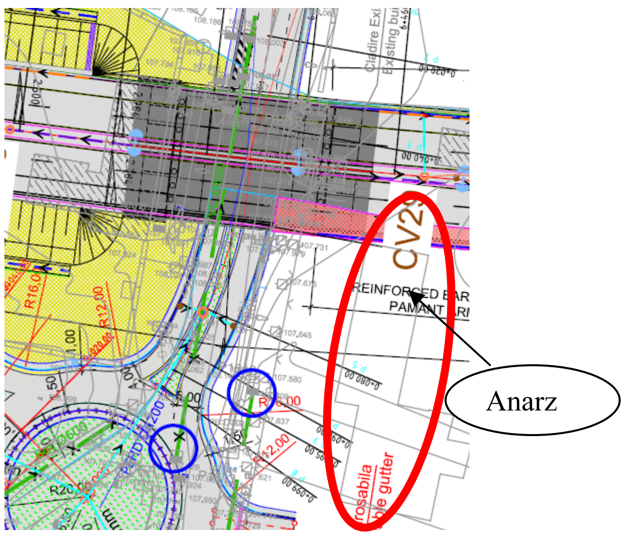

Fig.1. Situation Plan

The case study is conducted during 2011-2012, to the ANARZ building, located in the immediate vicinity of course of the highway, the descent from the cross passage Bodrogului Way-defined as 6 km+460 on route, according to BYPASS yaw – situation Plan.

The building structure was executed under D.S.A.P.C. Timisoara adapted project in 1966, with load-bearing walls of brick masonry exterior normal of 37.5 cm and 25 cm inside, with concrete pillars as coupling rods between strong facade glass windows.

Fig.2. Frontage adjacent future's slope

The building belongs to the category of simple masonry diaphragms in cellular system topped with ground floor height. Foundations are continuous, width 50 cm, as bearing walls, 50x80cm in concrete pillars of the facade, is made of concrete with foundation depth of -120 cm.

The floor is made of prefabricated elements, round strips downloaded longitudinal walls with nominal length of 4.40m ... 5.00 and monolithic concrete slab over corridors with light of 150 cm. The roof terrace uncirculated type.

MATERIAL AND METHOD

Highway contractor, request in early 2011 for an Anraz-Arad evaluation of analytical quality and construction structure, to pursue its structural behavior under the effect of future work execution near the building.

Initial assessment of the building. The building is in risk class R III, falling under the effect of earthquake engineering design that can suffer major structural damage, but the loss of stability is unlikely.

Fig.3. Initial degradation

Therefore the above assessment it can be concluded that the current infrastructure of the building may be appropriate, but supra-structure, given that investor proposed interventions produce differentiated settlements on the east side building is not rigid enough to take these actions more. Fig. 4 indicate that there are cracks in the beam stands zone on the column and also sidewalk cracks**.** It takes into account the existing round strips slabs without reinforced concrete finishing (according P100-2006), which not provides "significant stiffness in plan" and lack of bracing walls in the transverse direction to the building. Following initial assessment is recommended:

- Making bracing walls in transverse direction of the building for enrolment it in a class above the present seismic risk. These walls will need to have independent foundations from the current foundations, to ensure cooperation with existing reinforced concrete walls or pillars in front.
- Consolidation of degraded areas of columns and of reinforced concrete beams that cracks in exploitation, by strengthening with reinforced concrete or carbon fiber lining and metal tie rods.
- In order to improve the behavior of structural elements to potentially seismic action or other outdoor activities, it is recommended to anchor the existing "floating" independent structure elements, such as existing chimney.
- To eliminate infiltration of rainwater in front or inside, we recommend restoring proper roof terrace and its connection to the attic perimeter.

Tracking behavior in time of building. After the initial assessment, we proceeded to track the behavior in time of building during the execution of this highway section. This action had two components:

- track foundation tamping of adjacent facade to the new building, where they ordered two landmarks on the top level of foundation corner;
- visual track of cracks in structural and non-structural (ex. partition walls) elements.

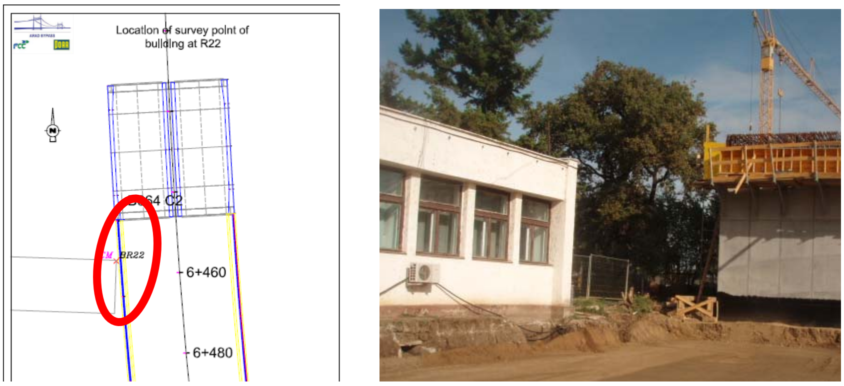

Fig.4. Location of survey point of building

Fig.5. Highlights wall support and on the foundation pillar

Follow subsidence: They ordered two landmarks on the foundations of the pillars corner facade as planned layout guidelines. Evolution of the foundation settling time closest support wall slope is shown in Table 1. It can be seen jumping reading level dated 18.12.2011 till 09.01.2012 on it due to the entry into service of the highway section. Following the occurrence of road traffic (especially transit vehicles, cargo transport) resulted in a significant difference in level between the two readings.

Table 1.

date	location : "Anraz"		
	level [m]	level differences	
		since last read	the initial reading
20.11.’11	107.941	x	x
27.11.’11	107.940	-0.001	-0.001
04.12.’11	107.939	-0.001	-0.002
11.12.’11	107.939	0.000	-0.002
18.12.’11	107.938	-0.001	-0.003
09.01.’12	107.934	-0.004	-0.007

15.01.’12	107.934	0.000	-0.007
22.01.’12	107.933	-0.001	-0.008
29.01.’12	107.933	0.000	-0.008
05.02.’12	107.933	0.000	-0.008
12.02.’12	107.933	0.000	-0.008
19.02.’12	107.933	0.000	-0.008
26.02.’12	107.933	0.000	-0.008
04.03.’12	107.933	0.000	-0.008
11.02.’12	107.933	0.000	-0.008
18.02.’12	107.933	0.000	-0.008

In fig. 6 is shown diagram that shows the evolution over time of Anraz building subsidence in the adjacent wall support:

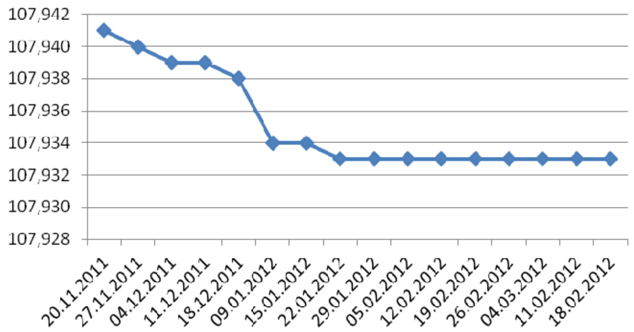

Fig.6. Settling time evolution

After 18.02.2012, subsidence evolved slowly, noticing their increased approx. 2mm, according to the latest reading from 04.10.2012:

Table 2.

date	location : "Anraz"		
	level [m]	level differences	
		since last read	the initial reading
20.11.’11	107.941	x	x
27.11.’11	107.940	-0.001	x
04.12.’11	107.939	-0.001	-0.002
11.12.’11	107.939	0.000	-0.002
18.12.’11	107.938	-0.001	-0.003
09.01.’12	107.934	-0.004	-0.007
15.01.’12	107.934	0.000	-0.007
10.07.’12	107.931	-0.002	-0.010
04.10.’12	107.931	0.000	-0.010

It can be appreciated that in July-September. 2012, settlements phenomenon were stabilized but can be reactivated at environmental conditions modification (autumn-winter rain / abundant snow, etc).

Investigation by visual. Following building investigations resulted after construction of the highway:

- appearance of cracks in walls in the vicinity bay - East;
- developing cracks in walls, horizontal or inclined cracks;
- development of cracks in the longitudinal beams openings in South and North facades and, on propping ends – corners of the East facade beams.

Building Reevaluation.

During May-June 2012, there were intensive aggravation of damages / cracks in structural and non-structural elements, with serious consequences for local resilience and stability of the building. Phenomena of subsidence of foundations in Eastern facade, confirmed by topographical measurements were generated:

- local breaking links between beams and columns facades their discharge in the building close to route highway slope, the slope of influential, especially in North facade, fissures / cracks in interior walls (non-portable), generated by rotating end of the building to support the embankment wall;
- fissures / cracks in lintels; breakings in attic of the teracce, in active area of the building.
- cracks at the interface between the floor strips and interior walls parallel to the strips;

Affected areas listed below have not included nonstructural walls. The areas most affected by compaction foundations of the Eastern facade with extension to the foundations of the South and North facades, are at the corners of the building and to the limit separation of significantly different rigidities from structural compliance of the building, due turning to slope of the building section, too.

Taking into account the state of emergency, the construction compliance and materials quality as a result of simplified qualitative and analytical assessment the building fall into Class I Rs, which include high-risk buildings from earthquake collapse properly design ultimate limit state.

Is estimated the probability of front bearing beams local rupture, their fall from their supports with engaging strips download onto these beams.

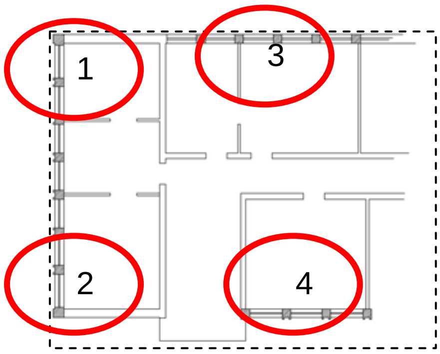

Fig.11. Major problem areas

Fig.12. Zones 1,2 and 4

PROBLEM SOLUTION

Proposals shall consist in urgent interventions, including local consolidation and general structural reinforcement to ensure overall resistance of the affected area from further probable effects of interventions. It takes into account too, compaction proposals for preventing affected area to collapse / local collapse in case of a very low intensity earthquake. Pending strengthen damaged area, is necessary to evacuate temporarily the building area heavily affected. Recommended work intervention, with the aim of individual strengthening of structural elements severe damaged, are:

- Providing supports for the beams of the facade, in areas with major faults. (Marked with 1, 2, 3, 4, in the failure plan).
- Introduction of cooperation tyrants, between front and corner.
- Injection areas with cracks / crevices with question-recommended grout at least, special mortar injection (SIKA type resin mortar, or similar, etc) in an appropriate technology to restore and protect local structural continuity heads fittings.

Recommended for general intervention works on the structure are:

- Making bracing walls to the transverse direction of the buildings for classification in a class above the present seismic risk. These walls will need to have independent foundations of the current foundation and ensure cooperation with existing reinforced concrete walls or pillars in front.
- Consolidating partitions walls, by lining with reinforced mesh in cement mortar. (2.0...3.0 cm).
- In order to improve the behaviour of structural elements to potentially seismic action, anchoring existing non-structural "floating" independent elements, such as existing chimney, is recommended.

CONCLUSION

Nowadays increasingly, structural engineers face with situations that are required to perform construction in close proximity to an existing building. The case study showed serious damage to local resilience and stability of the construction site. In these situations, even after consolidation of the structure, is appropriate to follow the behaviour in time of the building in question.

Current follow of the new or old buildings behaviour, returns to the owners and / or users. Personnel carrying out current tracking activity, will report it, to be mentioned in the Event Journal and will be included in the Technical Book of the building. If advanced building structural damages are found, the beneficiary will require the preparation of technical expertise.

It is recommended to avoid similar situations.

REFERENCES

1. ***, Documentation for “Consolidare clădire Agenția Naționala de Ameliorare si Reproducere in Zootehnie A.N.A.R.Z. Centrul Regional Timiş -- Filiala Arad, Calea Bodrogului nr. 3, Judetul. Arad”, Memorandum of Technical Expertise no. 67 / 2012, prepared by professor phd.eng. Tudor Dan Florian;
2. ***, P130-1999 Normative: Norms regarding the behaviour in time of construction;
3. ***, P100 / 2006 / 2008 Normative: Seismic Design Code / evaluation code and design of the retrofit to existing seismically vulnerable buildings;
4. ***, Normative CR 6 / 2006: Code Structural Design Of Masonry.