MONITORING OF THE SPECIAL CONSTRUCTIONS IN CONNECTION WITH THE REQUIREMENTS OF THE SUSTENABLE DEVELOPMENT

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Abstract: *Strong economy has resulted in the construction of imposing constructions. Many of special buildings (cooling towers, dams, nuclear, etc.) require special attention in terms of data quality service without danger, through time, monitoring the movements and deformations of buildings or their components. In the context of urban development registered in Romania over the past 10 years, with the realisation of some of power construction as volume and design, we can affirm the great importance that it is necessary to done at the track of the behaviour in time of these buildings. Through continuous collaboration of the engineering branches of, the construction activity it is correlated and completed very often completed with the adoption and application of some geodetic methods and technologies that are coming to record, to process and to represent the behaviour of the buildings subject to different perturbation factors. The progresses made in the last years in geodesy and topography fields have seen a giant step by implementing modern surveying technology and surveying methods adapted in the civil engineering at the to track of the behaviour in time some objectives importance. Engineering structures (such as dams, bridges, high rise buildings, etc.) are subject to deformation due to factors such as changes of ground water level, tidal phenomena, tectonic phenomena, etc. Cost is more than offset by savings and by improvements in safety both during and after constructions. As a result, the design, execution and analysis of such surveys are a matter of considerable practical importance. Deformation refers to the changes of a deformable body (natural or man-made objects) undergoes in its shapes, dimension and position. Therefore it is important to measure this movements for the purpose of safety assessment and as well as preventing any disaster in the future. The advantage of a real prognosis determination is the fact that in time the investments in these types of areas can be made on time and with maximum efficiency. Practice has demonstrated that by using 3D modeling and the analysis of the movements of the areas located in mining areas, the experts in the field have better tools to perform a good prognosis in time and a good monitoring in time of the techniques used for land protection and for the protection of the existing constructions in the affected areas.*

Key words**:** *monitoring, construction, 3D modeling, leveling, movement, deformation, laser scanning*

INTRODUCTION

Engineering structures (such as dams, bridges, high rise buildings, etc.) are subject to deformation due to factors such as changes of ground water level, tidal phenomena, tectonic phenomena, etc. Cost is more than offset by savings and by improvements in safety both during and after constructions. As a result, the design, execution and analysis of such surveys are a matter of considerable practical importance. Deformation refers to the changes of a deformable body (natural or man-made objects) undergoes in its shapes, dimension and position. Therefore it is important to measure this movements for the purpose of safety assessment and as well as preventing any disaster in the future.

The development of measuring techniques has permitted and created the possibility to observe and emphasize the behavior of the studied buildings. There are loads of classification criteria, methods of research and observation of buildings and structures.

Taking this into consideration, there have been criteria developed, made by types of

deformations, types of equipments and place where the equipments are situated during the observations.

By the place where equipment are located during the observations process there are two possibilities to determine the movements and deformations:

- physical methods: with the equipment located inside the building; in this case the equipment move at the same time with the building so relative movements and deformations can be evaluated.
- geometric methods: in this case, the equipments are placed outside the building or outside of its deformation area, the measurements will be linked to a network of fixed points situated outside of the deformation area and of the factors that can affect the building or the foundation ground that it is situated on.

Through this process there will be established absolute values of the horizontal or vertical movement. The topographic-geodetic methods belong to this category of determination of movements and deformations.

Monitoring the dynamic behaviour of large structures has been always a topic of great relevance, due to the impact that these structures have on the landscape where they have been built.

In our paper, in order to sustain our point of view, we are going to present an eloquent example, i.e.: cooling tower within the enclosure of CET Timişoara South.

Figure 1: The cooling tower from the area of CET Timişoara South

SC Colterm SA – C.E.T Timişoara South is located in the south of Timişoara municipal, in a densely populated area.

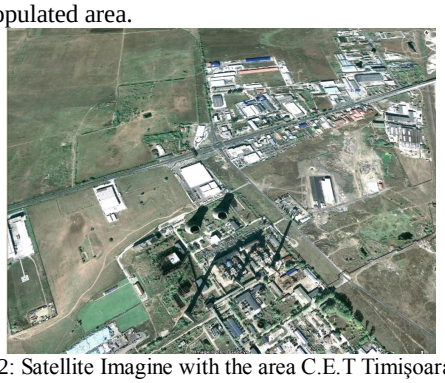

Figure 2: Satellite Imagine with the area C.E.T Timişoara South

MATERIAL AND METHODS

For the research study of the monitor vertical movements of the special power buildings foundations afferent to the C.E.T Timişoara South there were measurements made using topographic-geodetic levelling geometrical precision.

Field surveying was carried out geometrically round trip and closed circuit, between the base geodetic reference marks RF2, RF5, RF6, RF7, RF10, RF13, RF14 to determine their stability.

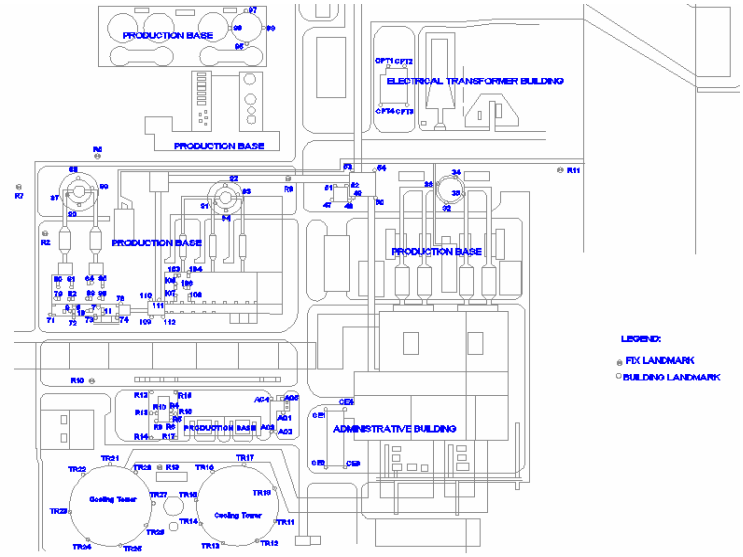

Figure 3. Sketch of landmarks reference within the enclosure CET Timisoara South-scale 1:5000

For the monitoring research study of the cooling tower from the area CET Timişoara South were performed measurements using 3D terrestrial laser scanning.

Figure 4: Terrestrial laser scanner

This new technology can be applied to all phases due to deformation of a special construction. Before the work begins it is necessary the accurate surveying of the terrain.

Both the preliminary and the actual planning process have to be highly accurate and detailed survey, which includes terrain elevation data.

RESULTS AND DISCUSSIONS

During the topo-geodetic measurements at CET Timisoara South no objective was in operation.

The temperature during the measurements was 17° C in the morning and 19° C at noon. Into the machine room the temperature was 18° C.

The geometric levelling was performed with Leica DNA 03 electronic level with coded invar surveyor´s staffs. The surveying instruments and invar surveyor's staffs used were checked and found that they technically are in good condition.

The compensation of the land measurements done on the land surveying routes they allowed the closure of 11 lines (circuits), was performed by the method of least squares, indirect measurements, using Leica Geo Office software on the basis of some programs specific to such of works, that are allowing in the end the displaying even of the accuracy of the determining settlements. The errors in determining the benchmark quotas rates are given in tables resulting from networks of levelling compensation. Accuracy is below the allowable tolerance, given by $T = -0.15 \text{ mm} + \sqrt{n}$, where n represents the number of levelling stations.

Table 1

Results table compensation levelling network

Point Id	Epoch	Height [m]	Corr [m]	Delta Hgt. [m]	Point Class	Sd. Hgt. [m]
RN13	**04/24/2009 10:12:11**	**87.38248**	-	-	Control	-
R17	04/24/2009 10:13:36	88.15158	-0.00005	0.76910	Measured	0.00003
TR12	04/24/2009 10:19:53	88.43278	-	0.28120	Measured	0.00001
TR15	04/24/2009 11:21:08	88.41038	-	-0.02240	Measured	0.00001
R6.1	04/24/2009 10:35:09	88.48383	-	0.07346	Measured	0.00001
R9.1	04/24/2009 10:36:59	88.45801	-	-0.02582	Measured	0.00001
TR18	04/24/2009 10:39:09	88.15485	-0.00007	-0.30316	Measured	0.00001
R6	04/24/2009 10:41:09	88.46043	-	0.30558	Measured	0.00001
R5	04/24/2009 10:41:50	88.45612	-	-0.00432	Measured	0.00000
TR13	04/24/2009 10:42:47	88.39174	-	-0.06438	Measured	0.00001
TR11	04/24/2009 10:43:20	88.48761	-	0.09587	Measured	0.00000
R4.1	04/24/2009 10:47:57	88.75464	-	0.26703	Measured	0.00000
TR14	04/24/2009 10:49:05	88.41272	-0.00011	-0.34192	Measured	0.00002
R4.2	04/24/2009 10:52:36	88.61047	-	0.19776	Measured	0.00001
TR17	04/24/2009 11:53:35	88.40509	-	-0.20538	Measured	0.00001
TR16	04/24/2009 10:54:50	88.41543	-0.00015	0.01034	Measured	0.00001
R9.2	04/24/2009 10:57:31	88.76150	-	0.34607	Measured	0.00002
R9.3	04/24/2009 10:58:36	88.47720	-	-0.28431	Measured	0.00002
TR18	04/24/2009 11:00:30	88.15195	-0.00019	-0.32524	Measured	0.00003
R13	**04/24/2009 11:02:25**	**87.38248**	-	-0.76947	Control	-

The advantage of a real prognosis determination is the fact that in time the investments in these types of areas can be made on time and with maximum efficiency.

Practice has demonstrated that by using 3D terrestrial laser scanning and the analysis of the movements of the construction, the experts in the field have better tools to perform a good prognosis in time and a good monitoring in time of the techniques used for land protection and for the protection of the existing constructions in the affected areas.

Modelling 3D constitutes a first reference for geo-3D modelling and the data analysis, being able to be used for studies on many important directions and in various fields, such as: geophysics, mining, hydrology, environmental protection, constructions, archeology, meteorology, etc.

The work was done by a Leica Scan Station C10 instrument. The laser scanner set to point cloud resolution of 10 cm. The survey contained three stations. We made measures to HDS targets in every station. The laser scanner scanned the neighborhood of the targets, and the locations of the HDS targets are determinable from the scanned point clouds (figure 5).

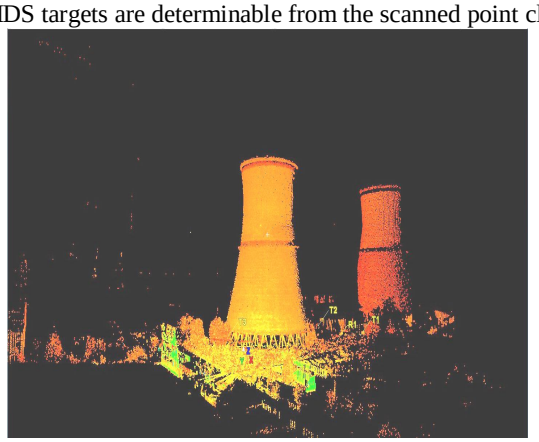

Figure 5: The finally point cloud of the workspace

These points can then be used to extrapolate the shape of the subject (a process called reconstruction). If color information is collected at each point, then the colors on the surface of the subject can also be determined. The Scan World contains one joint Model Space with each point clouds of the stations.

The 3D study can integrate geological data, topo-geodetic measurements, aerial or satellite images, maps or other GIS data. The entities used for modelling get a certain degree of intelligence, being maneuvered and aggregated according to the user's intentions, in order to give him the best convenient solution from the perspective of the needed study.

CONCLUSIONS

The application of the modern topo-geodetic methods to the study of the behaviour of different types of constructions represents an essential condition in the real highlighting of the evolution in time of a part of the construction or of whole structure as a whole.

The measurement, the processing, the calculation and the representation of the settlements, horizontal movements or inclinations of the tall buildings can be done today with modern topo-geodetic technologies, automated, which associated with the correct application of some specific methods, gives the guarantee of a fair highlights of the phenomenon of the buildings instability. With the help of the new geodesic methods and technologies with high degree of automation, the field of construction observation behaviour submitted to different disturbance factors becomes a branch of topical with applicability to various types of civil engineering, in close connection with the requirements of urban development and environmental protection.

The results obtained after a 2-year study confirm the need to:

- implement this new technology to monitor the high constructions;

- use topo-geodetic measurements as well as geo-3D modelling, as a system which can provide a permanent control, and which will be able to monitor the behaviour in time of the construction movement phenomenon. A system able to signal efficiently, in real time any modification that can lead to potential damages to the environment.

In context of evolving technology, more and more potential domains for 3D laser scanning applicability appeared, starting from its obvious advantages: measurements without direct contact, high precision, quickness data acquisition, results delivery in a shorter time, etc.

Laser scanning technology represents a first reference for GEO-3D modelling and data analysis, being able to be used for studies on many important directions and in various fields, such as: geophysics, mining, hydrology, environmental protection, constructions, archeology, meteorology, etc.

These are some of the reasons for which a possible prognosis in time of the movement of special constructions can make the investments in these areas continuous and made with maximum efficiency.

BIBLIOGRAFY

1. BREBU F. M., M. MARIN, A. C. BĂLĂ, Monitoring of the Building Energy in Connection with the Requirements of the Sustainable Urban Development and of the Environmental Protection, Journal of Environmental Protection and Ecology, Timisoara 2010
2. GRECEA C., A. C. BĂLĂ., Impact of Surveying Engeering on the Environmental Protection Problems, Journal of Environmental Protection and Ecology, Turcia 2009
3. HERBAN S. I., Developing Models in the study and the traking of movement of buildings, Journal of Geodesy and Cadastre, RevCad nr.7, pp.33-40, Alba Iulia 2007
4. HERBAN S.I., C. C. MUŞAT, Determinate dynamic deformation of construction using the integrated system Leica 1200, RevCad nr.10, Alba Iulia 2010
5. HERBAN S.I.., Developing Models in the study and the traking of movement of buildings, Journal of Geodesy and Cadastre, RevCad nr.7, pp.33-40, Alba Iulia 2007
6. WAN AZIZ, W. A., OTHMAN Z. & NAJIB H., Monitoring high-rise building deformation using Global Positioning System, University Technology Malaysia,Skudai Malaysia