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Monitoring of hydropower construction using modern Geodetical methods

Alina Corina Bălă[1]   Floarea Maria Brebu[1]

Abstract— Tracking behavior in time of construction is carried out throughout the period of their life from its execution and is a systematic activity of collecting and exploiting information derived from observation and measurements of phenomena characterizing the properties and sizes of buildings in the interaction with the environment ambient and technology.

In context of urban development recorded in Romania with the development of major construction such as: dams, bridges, silos, blast furnaces, chimneys, cooling towers, tall buildings etc., we can say that they draw after some deformations that many arise both during construction and after their completion.

Hydropower constructions in general represents a construction with very likely long previous life and achieve their financial efforts imply particularly important. Their supervision during construction, first put under load-and on the full length represents guarantee their safety and prevent accidents that can become catastrophic.

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 behavior 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; their systematic monitoring of special scientific and practical importance.

Keywords—monitoring, construction, landmark, environment, movement, deformation

1. 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 [1].

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 is 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, 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 [2].

Compared to other types and categories of construction, the hydro have usually, some particular characteristics of which reads:

- public nature, meaning that the utilities are represented beneficiaries large communities, regardless of the type of use or ownership of the

[1] "Politechnica" University of Timişoara, Faculty of Civil Engineering, Romania, e-mail: alina.bala@upt.ro

holder, and costs borne by large groups of the population;

- investment and operating costs are very high compared with those of other types of construction or technological installations , costs arising , in particular, very large volumes of work ;
- total disaster damage are usually very high and the risk of casualties is real ;
- hydraulic, and especially dams , have a long lifetime high ;
- hydraulic takes a very wide variety of functions , types, and natural conditions, quality of materials and especially foundations conditions are always different ;
- uniqueness and size of many hydraulic structures to make them find the prototype situation. [3]

Consequences of approach necessary safety issues and risk, has some special features:

- issue of fair balance between the costs of implementation - operation and possible costs due to damage, direct interest, economic and vital social strata wide, very often at the national level and at the political involvement of their representatives is essential;
- diversity and complexity of building types and natural conditions exclude practicality of detailed technical regulation and standardization methods sizing, testing and analysis;
- needs assessment and knowledge of the risk involved, leads to the need approach probabilistic safety analyzes;
- professional competence of the staff is the most important condition to achieve safe operation of dams.

From statistical studies made that the average risk of the destruction of a building type hydro dam is about 0.5%, and the risk of shutdown for an extended period, as a result of accidents, is about 2% - 3%.

Analyzing the destruction of dams recorded, it is clear that the vast majority are due flippancy with which they were designed, built and operated. The first measure to be taken is to subject all dams a very strict control in all phases of design, construction and operation.

Secondly, during exploitation, dams and lakes should be closely based on measurements and observations. Dam break accidents do not occur suddenly but almost always there are preliminary indications of danger which would allow taking measures to limit or even avoid disasters.

From the dam breaking analysis found that the percentage risk of destruction is much higher in low height dams higher than the dams. Explanation is that the big dam adopt higher safety factor.

Safety coefficients must be enacted according to the size dam but on the consequences of breaking, given the following directions:

- follow according to the importance of dams that damage would occur downstream from a possible rupture (deformation and seepage monitoring);
- treating problems geotechnical field studies to establish operating conditions given in the main consequences of dam failure;
- treating the problem dike or dam stability and resistance differently, depending on the consequences of breaking.

In order to reduce risk factors and to avoid destructive effects in the destruction of dams and other outbuildings (penstocks, canals, etc.), it requires constant surveillance while their behavior. Visual observations are made over the entire work and on the phenomena that affect stability work.

The dams of local materials is the maximum weight of observations related to seepage and slides. Concrete dams are therefore especially cracks and relative displacements plots.

For areas of the dam submerged recourse to divers equipped with video cameras, anomalies detected at visual examination of areas are photographed repeatedly at certain intervals depending on the evolution from landmarks tracking.

Dams works with foundations and slopes and shows permanent deformation under the influence of water pressure and heating from the sun. In the period they occur daily and seasonal oscillations related to filling and emptying tank.

The buildings appear larger tectonic movements induced accumulation and dam. To follow up is recommended displacement oscillations and reference system - microtriangulation - the landmark set outside of the influence of the dam, which are followed in relation to the construction landmarks fix. Measurements are made with a higher frequency in the first period of operation of accumulation and subsequent periodic checks are made; if deviations from normal movement limits set by the designer, to make their analysis and interpretation [4].

Supervision of construction hydraulic behavior in time is based on the evolving nature of the track parameters. These parameters are based on the value early when work is commissioned and stabilizes at certain values allowed by the designer, periodic evolving values.

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

Monitoring the dynamic behavior 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.

2. MONITORING CERNA DAM USING MODERN TOPO-GEODETIC TECHNOLOGIES

In our paper, in order to sustain our point of view, we are going to present an eloquent example, i.e.: Dam Cerna of town Băile Herculane from Romania.

In close proximity Baile Herculane you will find Dam Cerna, forming a beautiful lake and spectacular. Dam

Cerna also known as the Valley of Jovan is made of rockfill material waterproofed with clay and ranks the top 10 dams in height from Romania. It is part of hydropower Cerna-Balerca.

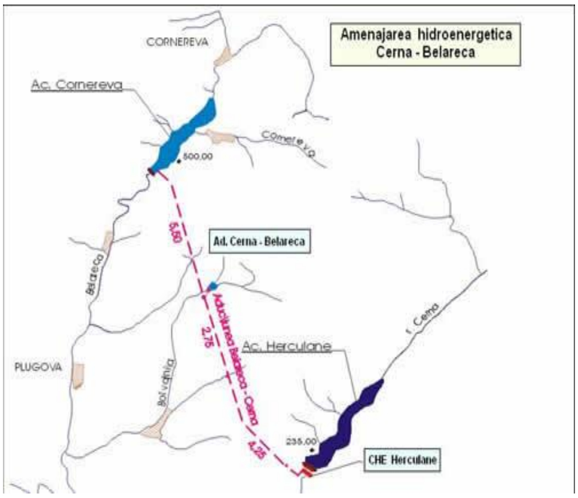

Figure 1.Hydropower Cerna-Balerca

Cerna Dam is a concrete arch-type dam, founded on massive granite is gradually sinking, upstream and downstream, in sedimentary deposits. In the left side, about 250 m from the dam shoulder, granite rock formations is limited by weak, intensely altered, consisting of shale clay-marl, marly limestone and sandstone shale, which is a weak area with the retention. The dam was inaugurated in 1979 and has a length of 342 m and a height of 110 m.

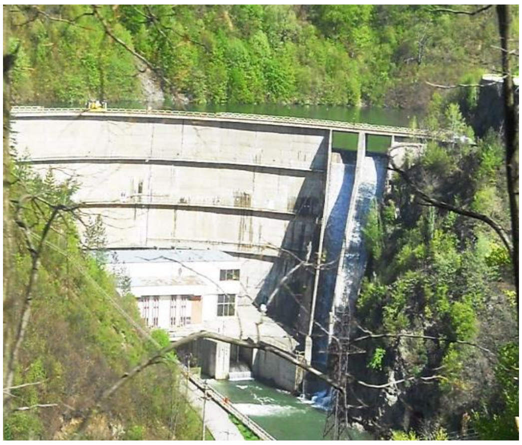

Figure 2. CERNA Dam

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.

Topo-geodetic measurements carried out at dam CERNA aimed at monitoring horizontal and vertical landmarks of tracking embedded in this construction.

Microtriangulation network consists of six pillars, P1, P2, P3, P4, P6 and P7, 36 landmarks plots embedded in dam and 20 landmarks situated in coping dam.

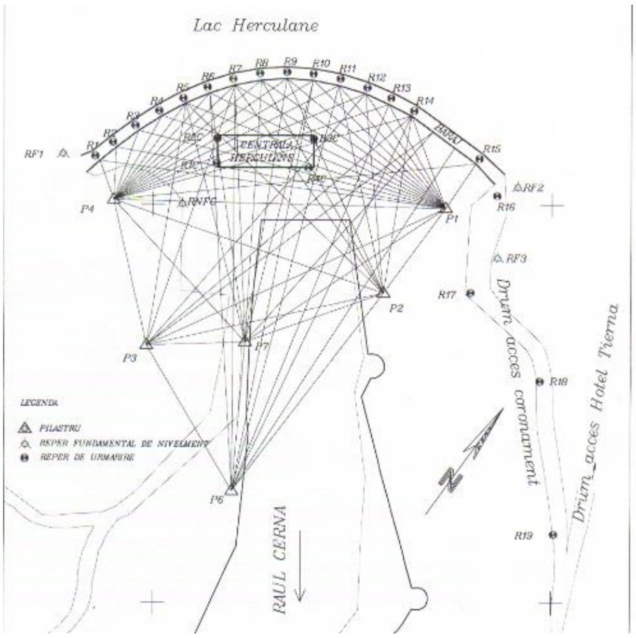

Figure 3. Microtriangulation Network

Pillars microtriangulaţie network are in good condition, paint properly to be spotted easily. Microtriangulation network measurements were made with a Leica total station 1201 + TCR which has a measurement accuracy of 1^{cc}.

Leveling network dam is formed of 15 landmarks tracking place on coping dam and 3rd place fixi leveling spotted at the ends of coping dam. The access road to dam are four landmarks tracking of leveling network.

3. ANALYZING DATA RESULTING

The maximum movement determined for benchmarks on coping dam is 10.3 mm at R6. Accuracy of movement's points of leveling network is 0.76 mm.

If the results meet such registration, in terms of geometric and considers acceptable, that is deviations results are within the accuracy required, resulting cloud of points unwrought a single coordinated system [5].

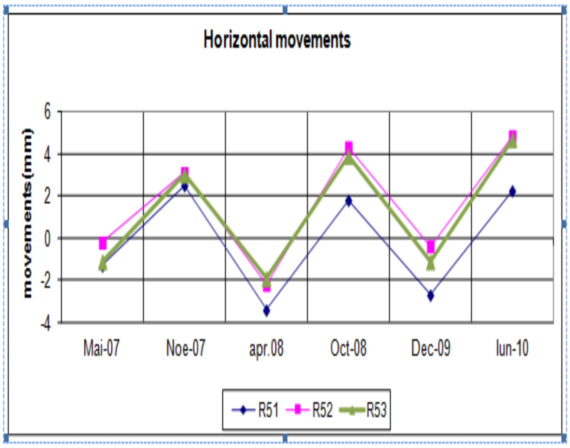

Figure 4. Horizontal movements of landmarks tracking [5]

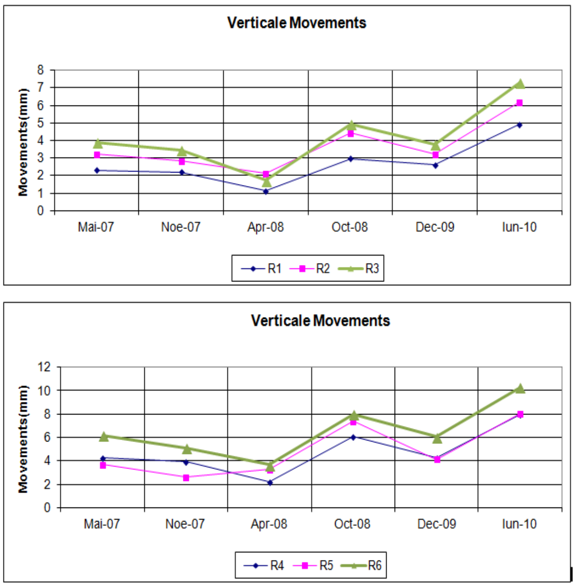

Figure 5. Vertical movements of landmarks leveling network [5]

On the basis of we conclude that modern topo-geodetic technology can be used to analyze the possibilities of tracking behavior in time of major construction in our country such as: dams, bridges, silos, blast furnaces, chimneys, cooling towers, tall buildings, etc., they result in some strain both during construction and after their completion.

4. CONCLUSION

The application of the modern topo-geodetic methods to the study of the behavior 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 behavior 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.

One of the key objectives of criminal behavior in time of hydrotechnical is to reduce risks to achieve the states limit, which would involve either loss of their ability to meet the operating conditions or generate hazards to people and property served. Referral time trends in operating loss of security is possible by making systematic observations and measurements on the parameters considered response characteristics by construction on exterior applications, such as structural deformations and displacements.

Application of modern topo-geodetic study of the behavior of different types of construction is essential in highlighting the real time evolution of an element of construction or the entire structure as a whole.

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