Journal of Young Scientist, Volume V, 2017
ISSN 2344 - 1283; ISSN CD-ROM 2344 - 1291; ISSN Online 2344 - 1305; ISSN-L 2344 – 1283

THE IMPORTANCE OF A CONCRETE DAM MONITORING

Raluca Gabriela KIVU, Carmen Mihaela PREOTESCU, Bogdan GHERED

Scientific Coordinator: Lect. PhD Eng. Catalina Mariana CALIN

University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Mărăşti Blvd, District 1, 011464, Bucharest, Romania, Phone: +4021.318.25.64, Fax: + 4021.318.25.67

Corresponding author email: kivu.raluca@yahoo.com

Abstract

Hydro tehnical structures are part of the strategic structures of great importance in terms of environmental protection, due both to their environmental impact and potential environmental hazards. The reason for their importance policy is twofold: on the one hand, water resources controlled by these structures are of vital importance for sustainable regional development (water supply for the population, agriculture, power generation, etc.), and on the other hand hydro tehnical structures presents one of the greatest dangers given the energy potential of their destruction (dams, dikes) or potential hazards (ponds, wastewater). The paper shows the importance of monitoring the behaviour of hydro tehnical structures and to establish the vertical displacements towards the base and previous slice of instalment. As a case study we chose the concrete dam from Herculane.

***Key words**: monitoring, concrete dam, vertical displacements*

INTRODUCTION

Monitoring and predicting the behaviour of hydraulic structures and adjacent areas represents a public priority. Ensuring the functioning of the projected parameters and corrective action most appropriate to preserve the functionality of these buildings is essential to: accident prevention and serious environmental and social consequences caused by natural disasters and technological accidents related to such construction; keeping appropriate environmental conditions of the surrounding areas of these buildings with an important role in regional sustainable development through sound management of natural resources (water, vegetation, crops, habitat).
Considering this fact, dam stability is monitored through topographic measurements regarding their vertical and horizontal movements (Manea, 2013; Onose et al., 2014).
In the case of concrete arch dams, horizontal displacements predominates, and in the case of rockfill dams, vertical displacement predominates (Ortelecan et al., 2014; Sails et al., 2014)
These requirements can be met by monitoring and overall supervision of hydro-technical facilities. Every significant hydro-technical construction should have its own surveillance program. The surveillance program should be appropriate to building size, risk level to which the public is exposed and other consequences of construction failure level. One of the most important parts of the surveillance program is to monitor geotechnical instrumentation fitted in construction, to ensure the integrity of hydro technical structures (earth dams and rockfill dams, concrete dams, tunnels). (Manea, 2013; Onose et al., 2014).
Dams are constructions with a long-life term, besides the fact that making them requires important investments. Supervising their behaviour during construction, from the first load and throughout exploitation is the guarantee of their safety and prevents accidents that may become catastrophes. Collected data from surveying dams allows making decisions about routine maintenance works at the best moments. They also allow knowing the eventual onset phase phenomena atypical behaviour and take action accordingly before such phenomena to be dangerous for the safety of the construction. Supervising dam behaviour is achieved through visual inspections carried out by qualified personnel and interpretation of data obtained from monitoring the behaviour of

relevant parameters with measurement instruments. At the current stage there is a general opinion that a monitoring system as complete and sophisticated as it is cannot replace direct visual inspection. Some of the most dangerous events such as local deformation, cracks, seepage concentrated wet spots cannot be detected by instrumentation. But once an abnormality has been detected by visual inspections through the monitoring system, its progress can be tracked and interpreted based on the data provided by the monitoring system.
To determine the vertical displacements on the weir crest and downstream face, tracking landmarks are placed to observe vertical displacements. Considering the small values of displacements, to record these displacements is used high precision geometric levelling and the measurement processing is performed by rigorous methods using functional models from conditioned measurements and from indirect measu rements (Dima, 2005; Onose et al., 2009).

MATERIALS AND METHODS

The purpose for following the review period of the behaviour of construction is to obtain information to ensure suitability construction for normal operation, evaluating the conditions in order to prevent incidents, accidents and damage or diminish damage, loss of life and damage to the environment (natural, social and cultural) and also obtaining information necessary for improvement in construction activities. Performing tracking actions for the review period of behaviour in time of constructions are made in order to meet the resistance requirements stipulated, stability and durability of construction and of other essential requirements.
Engineering companies and contractors are facing challenges never experienced before. They are being charged with and being held liable for the health of the structures they create and maintain. To surmount these challenges, need to be able to measure structural movements to millimetre level accuracy. Accurate and timely information on the status of a structure is highly valuable to engineers. It enables them to compare the real-world and real time behaviour of a structure against the design and theoretical models. When empowered by such data, engineers can effectively and cost efficiently measure and maintain the health of vital infrastructure. The ability to detect and react to potential problems before they develop helps in the reduction of insurance costs and the prevention of catastrophic failures that may results in injury, death or significant financial loss.
Topo-geodetic measurements made in order to follow the review period of the behaviour of constructions in time represents the only external check that may reveal that vertical displacements of the entire structure or construction with the foundation ground. In this case there must be reported certain points that are fixed to the building (survey marks) at a series of fixed points (fundamental benchmarks) located outside the area of influence of factors acting on the building and the land on which they are located (Table 1).

Table 1 - Measured points set on the Herculane dam

<table>
<tr><th>OBJECTIVE</th><th>OBJECT</th><th>LEVELLING</th><th>Micro- triangulation</th></tr>
<tr><td rowspan="5">HERCULANE DAM</td><td>PLANT</td><td>4 SURVEY MARKS</td><td rowspan="4">43 SURVEY MARKS</td></tr>
<tr><td>CROWN</td><td>15 SURVEY MARKS</td></tr>
<tr><td>ACCES ROAD TO CROWN</td><td>4 SURVEY MARKS</td></tr>
<tr><td>DRILLING DISPLACEMENT</td><td>6 SURVEY MARKS</td></tr>
<tr><td></td><td>4 FUNDAMENTAL BENCHMARKS</td><td>6 PILASTERS</td></tr>
</table>

Topo-geodetic measurements which were made to determine vertical displacements were conducted during September-November 2016, after which the data was processed at the office with a specifically software developed for this purpose. During performing the surveys, the ambient temperature was about 20 ° C to 4 ° C for levelling and micro triangulation measurements. Weather conditions were good, being able to perform measurements in optimal working conditions.
Micro triangulation network pillars are painted properly to be spotted easily. Also tracking marks from the access console are highlighted with paint and properly numbered (Figure 1).

Figure 1. Survey mark and pilaster

Pilasters considered fixed in this tranche of measurements were P7 and P4. Vegetation was cleared pillars both among and between them and the dam, but there were areas where, due to increased vegetation on the steep, rocky slopes, could not penetrate. These problems adversely affect the accuracy of determining the horizontal displacement of the parts of the dam, both the faulty-of-sight and the refractive error lateral occurs when the distance from the axis of sight to objects or building is less than 0.5 m.
Compared to the previous tranche there were no pillars or levelling marks destroyed.
Installing the instrument on pilasters was made by mechanical (forced) centring. On the other pillars of the network was installed circular total reflection prism, having zero or constant targets of sight.
The method of angles measuring for planimetric network of the dam was series method (sets of directions trough Schreiber method), performed four series for the pilasters, and three series for survey marks.
Altimetry measurements made at Herculane dam aimed to determining vertical displacements of the dam by topo-geodetic measurements made on benchmarks tracking. Movements are obtained by the difference between the rates determined in the current tranche of measurements and the one from the initial tranche. The altimetry network consists of four fundamental benchmarks RF1, RF2, RF3, located at the ends of the crown and RNFC, located near the plant, and 29 survey marks placed along the crown, on the crown access road, 4 embedded in the plant and wells that make up the network of tracking sliding the left side (Figure 2).

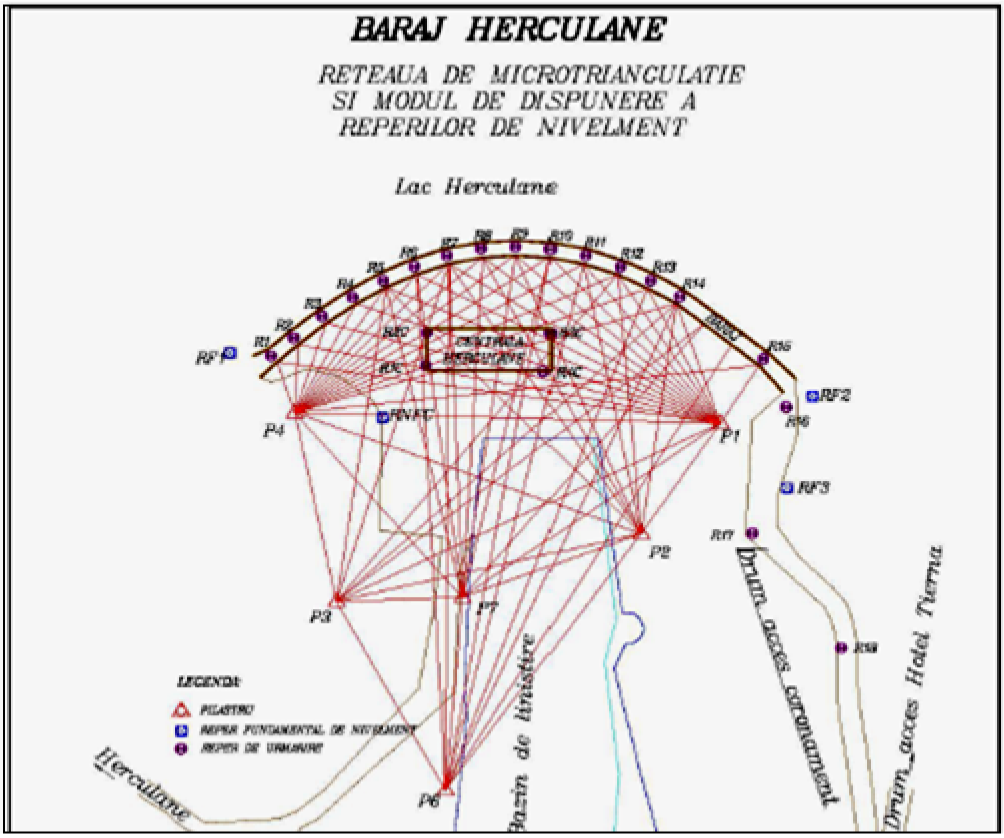


Figure 2. Micro triangulation network and the arrangement of the levelling marks

To determine the height of the marks embedded in the plant was made a closed traverse levelling on starting point, considering fixed the fundamental benchmark RNFC and for determining the height of the marks placed on the crown was made a traverse supported at the both ends on fundamental marks RF1 and RF3.

The works were performed with high precision equipment, both for surveying networks, and for microtriangulation. For microtriangulation stage respectively measuring directions and distances were used Leica total stations type TS 06. For levelling stage were used Leica Sprinter 250M digital levels, 3m barcode staff and levelling frogs 5 kg each (Figure 3).

Figure 3. Leica Sprinter 250M and barcode staff

The device used is the Leica Sprinter 250 M - is an electronic level automatically meant the measurements accurate and more precise, no skipping: USB interface, friendly menu, automatic calculation of height and elevation difference, applications for surveying, internal memory (250M) for measurements of height with a standard deviation of 1.0 / 0.7 mm * per km double levelling.

Test method for detecting vertical movements was middle geometric levelling method. Traverses high precision geometric levelling was carried out on the basis of the technical requirements of the 1 order of geometric levelling.

RESULTS AND DISCUSSIONS

Figure 4. Herculane dam

Accumulation Herculane, Cerna river located about 7 km upstream from Baile Herculane has 235 mdM NNR quota share which is 75.2 ha area. Multiannual average flow of the river Cerna, section barring order difference Cerna basin downstream from the dam is 5.1 m / s. Accumulation volume is 15.8 million cubic meters, of which 13.1 million cubic meters of useful energy and feeds on the distinction basin flow Cerna and the accumulation derived from Cornereva (Vele et al.2014, http://www.hidroconstructia.com).

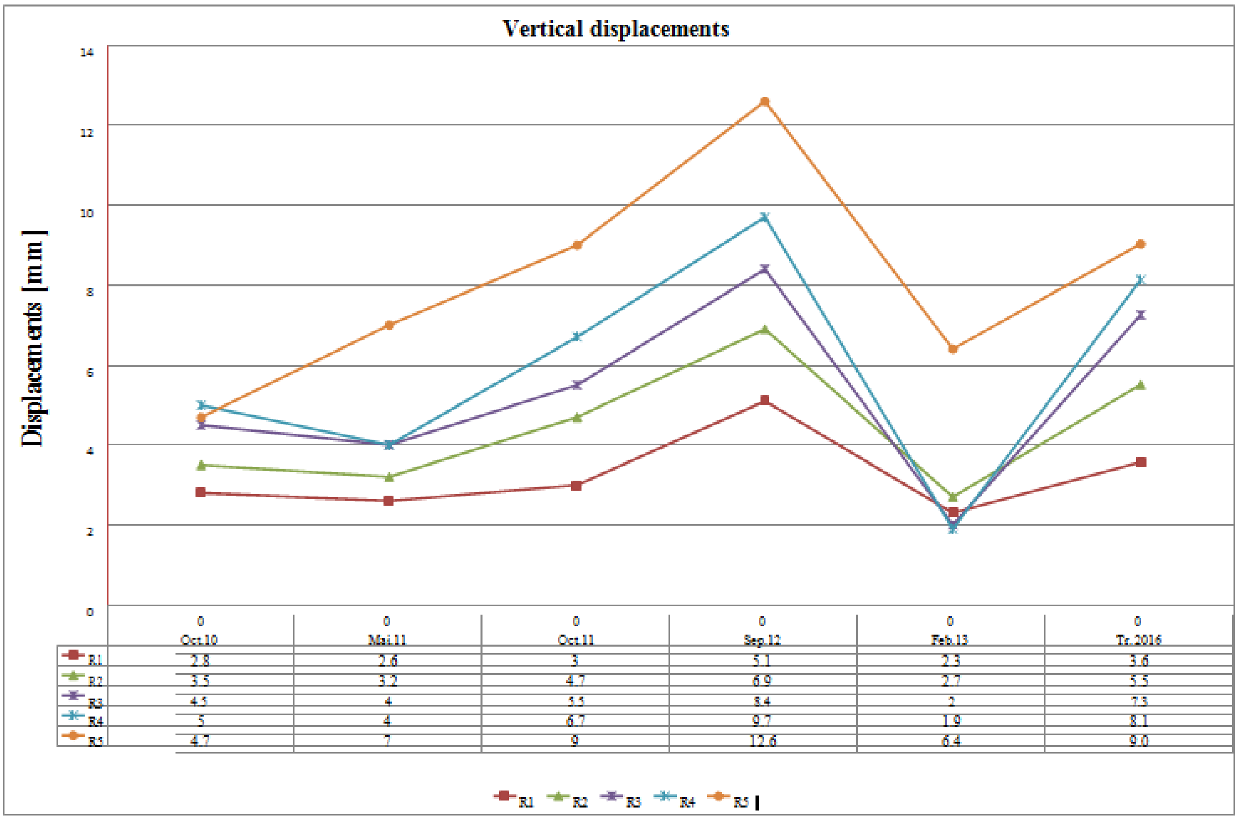
Dam, concrete arch, is founded on a massive granitic time Cerna of about 600 m length was sinking slowly upstream and downstream under sedimentary deposits. In the left side, about 250 m from shoulder dam, granite is limited by rock formations weak intensely altered and consists of shale clay marl, marl, limestone and sandstone marl, the area is a weak point, with permeability high of front retention.

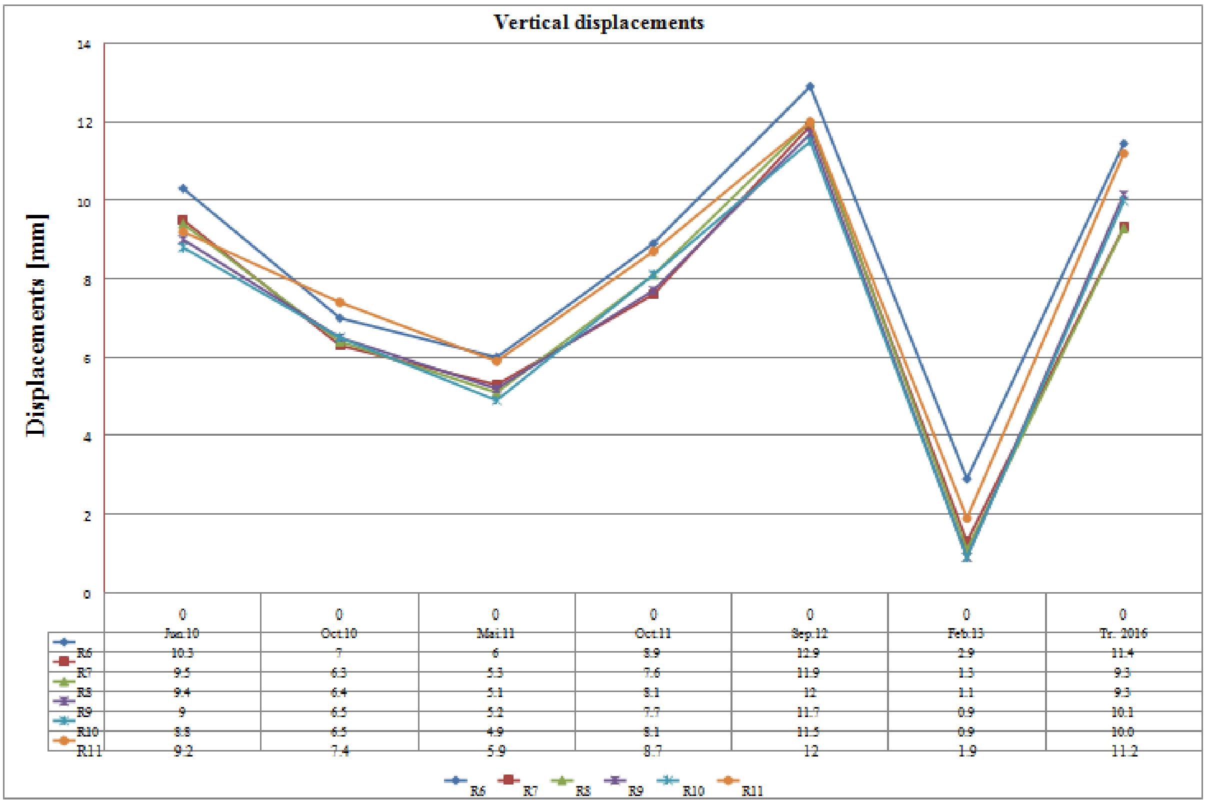
In this situation sealing dam was made with a veil sealing 540 m long and 27-50 m depth, the entire front of retention consisting of dam slopes, on two floors of galleries to share bed and canopy (8500 ml). Injections were associated with a network of drainage wells 25 - 45 m total length of 5800 m.

The dam is equipped with a perimeter gallery for injections, drainage and AMC, 2 galleries with 3 floors and access walkways to the downstream.

The dam is provided in plots 3 and 4 with two openings spillway without gates (length front spillway, 16 m), with channels exhaust 50m. Sleeps calculation is 530 m / s (of which 320 by trucks) and verification of 930 m / s. Bottom purges in number two plots located in the 8th and 9th, ensure discharge of 210 m³ / s at NNR. They are made of metal pipe d = 1200 mm total length of 65 m of which 10.70 m under pressure, equipped with crosspieces revision and valve segment and the downloading manoeuvre under power.

With measurements performed their interpretation was made comparing with those previously made. Graphic representations of survey marks differences in the crown vertically acquired from the monitoring process can be seen in the charts below.





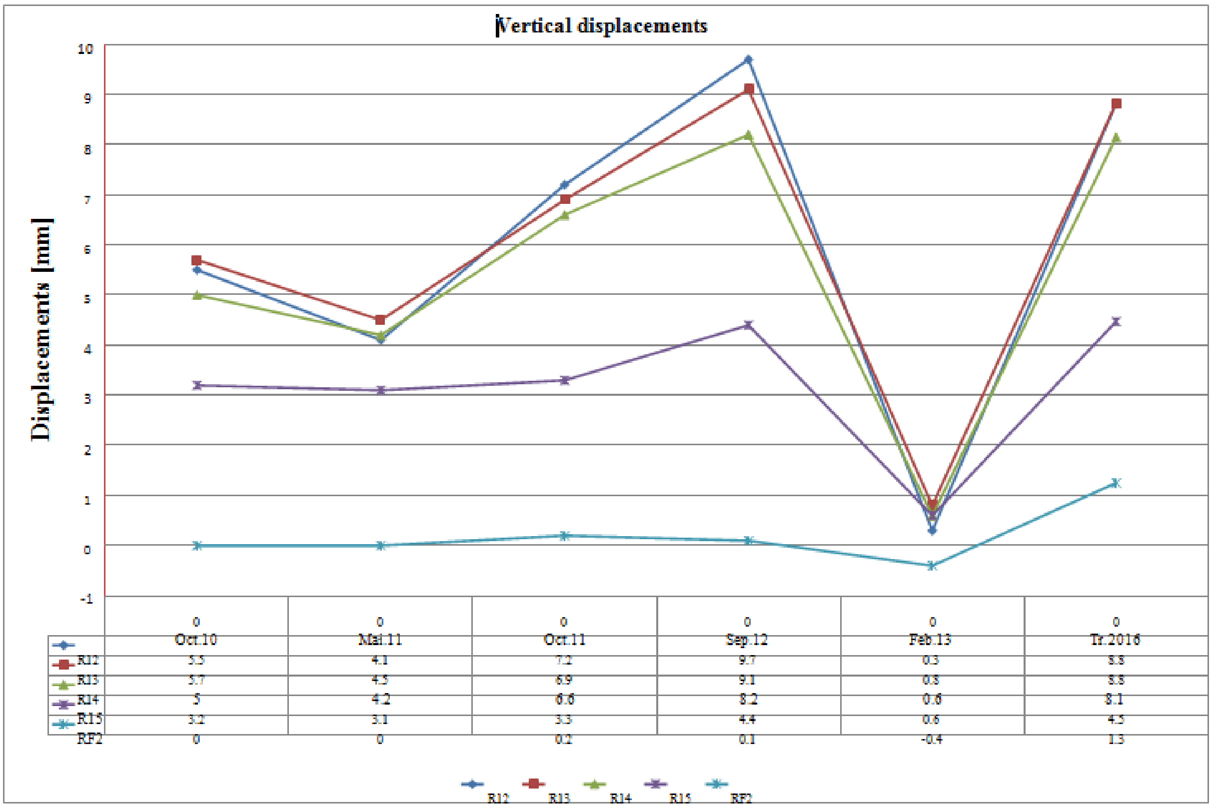


Figure 5. Vertical displacements obtained on the crown marks

CONCLUSIONS

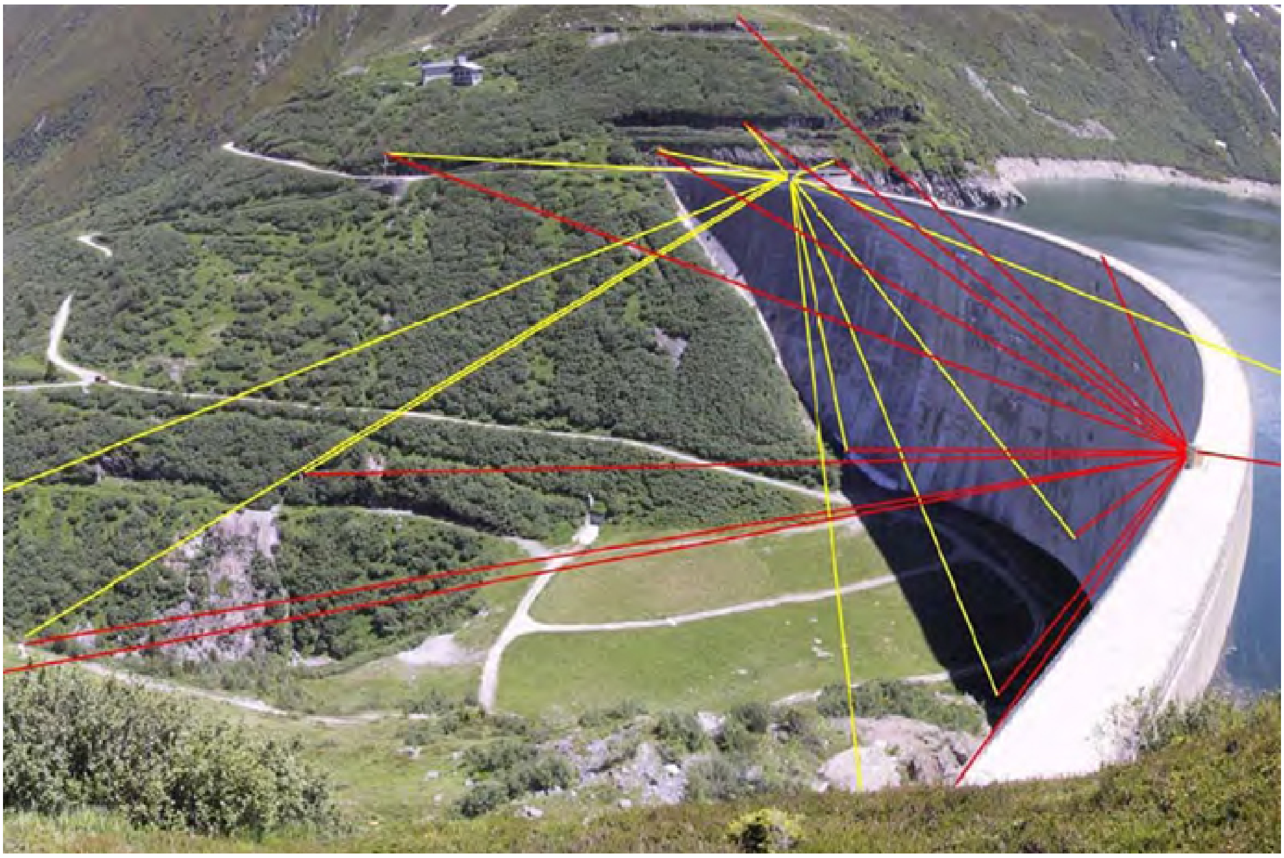


Figure 6. Dam Monitoring

It can be seen from comparative graphs that there isn't significant displacements of both the initial tranche, and to the previous tranche for the remaining marks that make up the network of tracking altimetry.

Hydro technical structures behaviour monitoring (Figure 6) by geodetic methods is an important component to ensure safe operation of the hydro, thermal and nuclear - electric objectives. When networks tracking optimally compliant and stable the instrumentation can provide the precision required if measurements are good and the mathematical model used for the processing of land is suitable, then it can highlight the changes over time in terms of geometry tracking network.

Monitoring systems are an essential part of risk management. By providing the early detection of instability they have prevented slope failures from causing injury, death and financial loss.

REFERENCES

Dima N., 2005. Geodezie, Ed. Universitas, Petrosani.

http://www.hidroconstructia.com

Manea R., 2013. Topografie, Ed. Noua, Bucuresti.

Onose D., Savu A., Negrila AFC. and Raboj D., 2014. Topografie, Ed. Matrix Rom , Bucuresti.

Onose D., Savu A. and Negrila AFC., 2009. Traching Behavior in Time of the Bridge Over the Danube Black Sea Chanel from Cernavoda, Sustainability In Science Engineering, Proceedings of the 11th WEAS International Conference on Sustainability in Science Engineering (SSE '09), Published by WSEAS Press, Volume 1 Timisoara, Romania ISSN 1790-2769, pg. 207-212.

Ortelecan M., Pop I., Salagean T., Sestas P. and Pop N., 2014. Aspects Concerning the Processing of Observations in Supprts Networks Related to Hydropower Objectives, Bulletin USAMV Horticulture 71(2) / 2014, ISSN 1843-5254, pg 437-444.

Vele D., Pop I., Ortelecan M. and Salagean T., 2014. Aspects Regarding the Monitoring of Weight dams by Geodetic Measurements, Rev Cad 17/2014, ISSN 1583-2279, pg. 161-168.