THE CONCEPT OF SUSTAINABLE DEVELOPMENT APPLIED TO RETECHNOLOGIING A HYDROELECTRIC POWER PLANT

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Abstract: *The world where we live is in constant changing. The concept of sustainable development, through the fact that it refers to the optimal resources management that can be efficiently and on long term utilized, is about limiting the effects of human activity towards the environment. Considering that domestic and industrial activities are based in a very large proportion on electricity, the way of its production represents an important concern. This is an important issue because Romania is a country which has renewable energy sources, which are not exploited at the optimal utilization capacity. To unlock the potential of renewable sources is needed an energy strategy that leverages these renewable energy sources and that our country to align with the current European trends. Besides of implementing the electric energy generating solutions through alternative solutions, an element of high importance represents the optimization of the potential use of energy. The monitoring systems provide the right solution for surveying the structure of a long bridge, an hydraulic layout, the movement of a slope, or tracking the settlement of a dam or a building. 3D geometries play a special role in the modernization projects developed within the existing ones. This paper present the research stages in order to optimal water energy utilization and the identification of the turbines production capacity increasing possibilities. For achieving this porpoise a complex topographical survey was necessary to highlight the real situation. The topographical measurements were performed using Leica 1205 TCRA total station. The topographical measurements were performed in the following areas: the penstock area, near the butterfly valve and in the spiral case area. The data, obtained from the topographical measurements, were compared with the reconstructed 3D geometry, based on the documentation made available by the beneficiary. Based on the differences between the two geometries the modernization conclusions were presented.*

Key words: *sustainable development, monitoring, 3D reconstruction, polar coordinates, hydraulic layout.*

INTRODUCTION

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, engineers need to be able to measure structural movements to millimeter 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 behavior 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 main purpose of our measurements represents the evaluation of the real conditions from the Bradisor hydro power plant. The data from the technical drawings were verified on the field, for evaluating the real situation. As a result, measurement of the hydraulic path, upstream of the hydraulic turbine (the penstock area nears the butterfly valve and the spiral case). The obtained results were compared with the data from the technical drawings for the discrepancy determination.

MATERIAL AND METHODS

The point spatial coordinates measurements process using electro-optic measurement and the Electronic Distance Measurement model were used for the field measurement. The spatial measurement process makes possible a direct tridimensional point coordinates. The object points Cartesian three dimensional coordinates are determined with measuring instruments, using the orthogonal method, generate - by constructive conditions – a rectangular coordinate system.

The method is utilized for surveying topographical details which take place predominantly one side and the other of a reference alignment (A-B), which can be a side of a traverse and the terrain is about horizontal ($p<5^g$). This method also can be used for surveying characteristic points of the buildings façades, the ones characteristic of technical facilities in localities and also for surveying the plot limits, the lake contour or the river banks and for surveying in the close domain (industrial buildings, special constructions and quality control of finished products) or - in general – the characteristic points coordinate determination of different shape and size details.

The method principle consists of measuring from point A the reference leg, on the alignment A-B, from the abscissa AP1=d1=a to the perpendicular foot high with the help of a topographical square, from the alignment to the detail point P ($\beta=100^g$). On the new direction the ordinate P1P = d2 = b is measured until P point of the topographical detail, which must be surveyed until A-B alignment. [3]

In the present day all the known companies building topographical instruments offer so called Measurement Systems in Industry, with whose help can be determined points in a tridimensional system, throughout multiple direct intersections in the close domain.

In the Industry Measurement Technique there are two types of systems, which work after this principle:

- Industry Measurement Systems which utilizes the theodolite, that can measure bearings toward the object points;
- Photogrammetry Measurement Systems that deducts the bearings are deduced from the image coordinates.

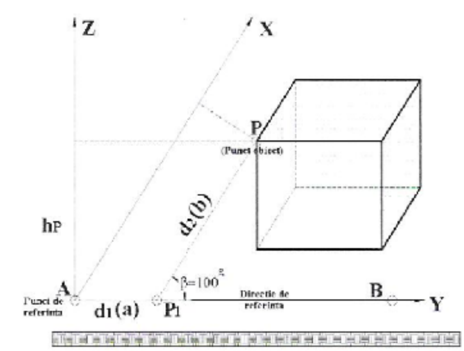

Figure.1 The rectangular coordinates measurement principle [3]

Both systems work without direct contact with the measured object. Due to the facilities and to the mobility that these systems offer, they allow measuring objects of different shapes and sizes. Another geodesic method for determining the spatial coordinates is offered by the instruments which work according to the surveying principle by polar coordinates method. For using this method only one station point is sufficient to achieve the tridimensional coordinates (3D). The object point coordinates are calculated from measured elements: horizontal angles, vertical angles (zenithal angles) and tilting range. [3]

Measured elements:

- horizontal angle ω_A (relative to the reference point direction)
- tilting range S_{AP}
- vertical angle β_A

The local coordinates system definition:

- the system origin is in the theodolite pointing center from point A (0, 0, 0);
- Oy axis direction to the point of reference.

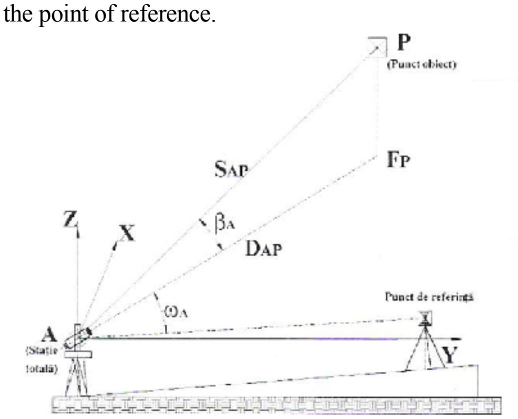

Figure.2 The measuring principle for determining coordinates through polar method [3]

Utilized Instruments/Programs:

Total stations are part of the new topographical instruments generation, having in principle, the functionality of a classic tachymeter. They are electronic instruments capable to determine most of topographical elements on the field (angles, distances, level differences and surfaces), to perform through software many integrated topographic calculations and to store the field data in electronic memories. In the structure of a total station are included the same axis, the same main components and the same moves of the classical known instruments, plus the electronic part incorporated in the casing. [6]

RESULTS AND DISCUSSIONS

The method used for determining the spatial coordinates is the polar method. In contrast with the space intersection where are necessary two station points, using this method only one station point is necessary for determining the tridimensional coordinates (3D). The object point coordinates are calculated from measured elements: horizontal angles, zenithal angles and tilting range.

The local coordinates system definition:

- the system origin is in the total station pointing center, the station point with coordinates (0, 0, 0);
- Oy axis direction to the point of reference.

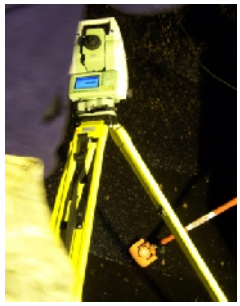

Figure 3. Defining the station point

Figure 4. The station point

This methods principle consists in measuring, from the station point of coordinates (0,0,0) the horizontal angle's side support and the horizontal distance, to the detail point, which rectangular plane coordinates will be determined based on the known coordinates and on the elements measured on the field.

Experimental data processing:

The programs used for data downloading, processing and setting off were:

- LEICA Geo Office Combined,
- TopoSys,
- AutoCAD Civil 3D 2010.

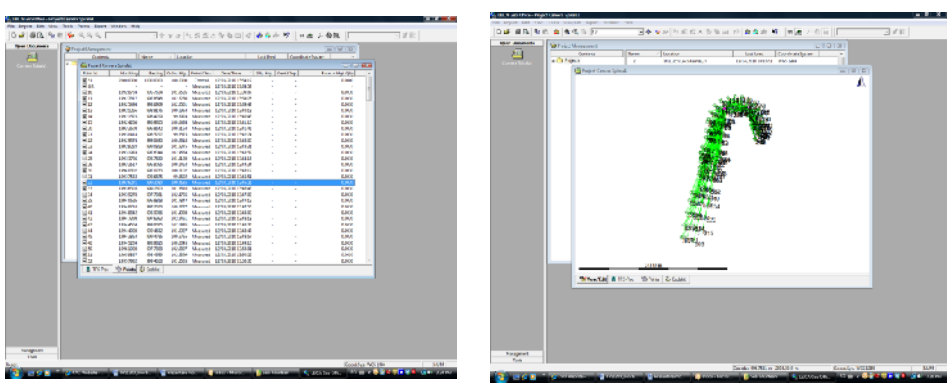

Figure 5. Withdrawn from LEICA Geo Office Combined

The hydraulic layout upstream the turbine runner includes: the enforced penstock (the area near the butterfly valve), the spiral case and the distributor (the stator and the guide apparatus). A reconstructed view of this layout is represented in the figure below.

CONCLUSIONS

Monitoring this kind of constructions is made both physical methods and topographic methods. The advantage of physical methods is that through the used gear they are providing information about the monitored construction behavior at small time intervals (hours, days, weeks). This information has a relative character because the measurements are made on certain construction elements reported to other construction elements. The topographic methods have an absolute character because the measurements are executed towards the construction independent reference system.

Based on the documents provided by the beneficiary (represented by the magenta color) and the new measurements (represented by the blue color) we made an accurate comparison analysis between the reconstructed 3D model and the measured one. Following the assessment we conclude that minor differences were found between geometry reconstructed based on the documents made available by the beneficiary and the data measured in situ. The geometric deviations found are within the accuracy of used measuring equipments and available in situ measurement conditions.

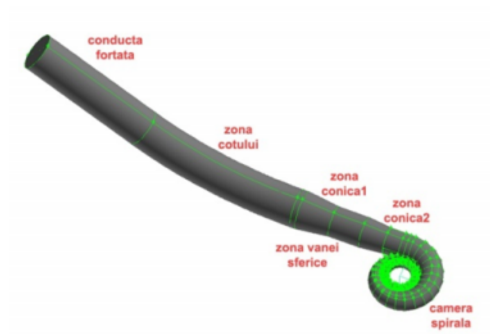

Figure 6. The reconstructed hydraulic layout 3D geometry [5]

Figure 7. Photo of the spiral case, the stator columns and of the guide apparatus

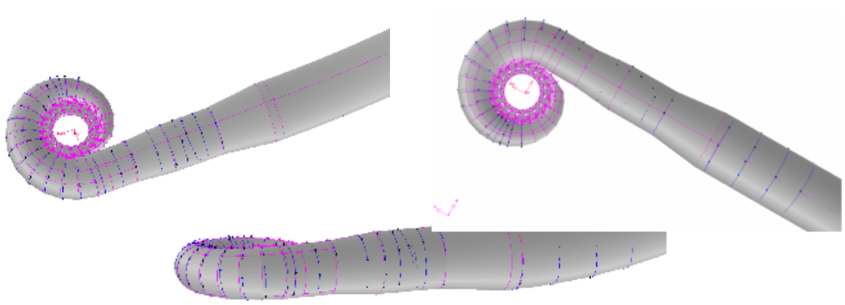

Figure 8. Views of the upstream hydraulic layout, 3D, reconstructed [5]

ACKNOWLEDGMENT

[1)]This work was partially supported by the strategic grant POSDRU/88/1.5/S/50783 (2009) of the Ministry of Labor, Family and Social Protection, Romania, co-financed by the European Social Fund – Investing in People

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