Geodetic Networks for Hydropower Plant System "Dabar" (Republic of Srpska - BiH)

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Abstract

In the paper geodetic networks for the hydropower plant system "Dabar" are described. Hydropower plant system "Dabar" is being designed for water acummulation in periods of flood and its utilization during dry periods of time. One of the purposes of accumulated water is to be used for producing electric power. The power house is derived more than 11 kilometers from accumulation. The connection between accumulation and power house is solved by tunnel. As a complex system the hydropower system "Dabar" should be covered with adequate geodetic networks and this paper aims to describe the solution of geodetic networks and their utilization during the life cycle of the system.

Key words: Hydropower system "Dabar", geodetic networks, life cycle of system

1 INTRODUCTION

Hydropower plant system "Dabar" is part of multifunctional system of Upper Horizons which geographically belongs to area between the Neretva River and the Trebišnjica River. The project of Upper Horizons aims to regulate the complex water regime according to water management, social, environmental, energetic and economic aspects. All existing analysis has justified this project in social and economic sense.

The main aim of this paper is to describe the geodetic networks which were established with purpose to provide required efficiency and accuracy of geodetic works all over the system and to cover entire life cycle of system. As a result of this approach the reconnaissance, design, stabilization and measurements of those networks shall be realized in appropriate way to meet above mentioned goals.

According to the state of art of geodetic technologies and the prices of geodetic works (and at last but not least their importance) it is possible to strive to the maximum possible accuracy with reasonable efforts.

On the Figure 1 the approximate location of hydropower system "Dabar" is shown.

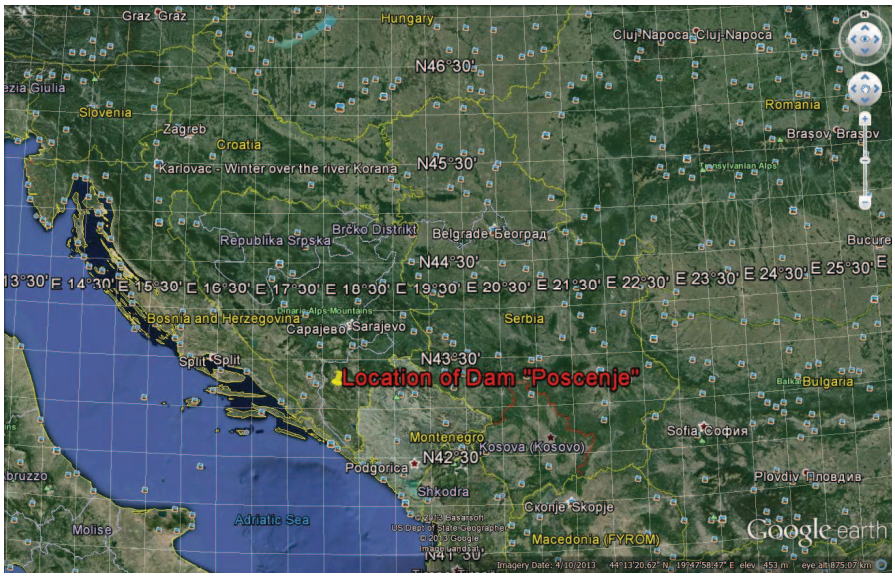

Figure 1 Approximate position of hydropower system "Dabar"(source: Google Earth)

2 DESCRIPTION OF HYDROPOWER SYSTEM "DABAR"

Derivative Hydropower plant system "Dabar" will use the water from accumulation formed by "Pošćenje" dam. To the aggregates in powerhouse water will be supplied by the derivative tunnel and pressure pipeline. The hydropower system "Dabar" is consisted of: dam "Pošćenje", dike "Grebak", dike "Vranjača", accumulation "Nevesinje", derivative tunnel, surge tank, pressure pipeline and powerhouse.

"Pošćenje" is designed as a concrete gravity dam situated on the Zalomka River. The length of the dam is 288 m and the construction height is 43 m.

Dike "Grebak" is designed to prevent the potential loss of water from accumulation and it will be made of rock with the concrete core. The length of dike "Grebak" is 485 m and it is situated approximately 500 m upstream from "Pošćenje" dam.

"Vranjača" dike is designed to prevent the flood wave even in the case of flood wave of 0.1% and if the accumulation was full and the hydro energetic system "Dabar" is not in operation.

Accumulation "Nevesinje" will be formed after the building dam "Pošćenje". Accumulation will cover the area of 904 ha with volume of approximately 60 000 000 m^3.

Derivative tunnel which will connect the accumulation "Nevesinje" and hydropower system "Dabar" is approximately 12 km long and with diameter of 4.6 m. Tunnel is designed to have 2 curves one on the beginning and one at the end.

Surge tank is of cylindrical type with two chambers (upper and lower). Pressure pipeline has diameter of 3.70 m and length approximately 500 m.

As every investments (but bearing in mind that investments in managing water and energy resources has specific weight) the hydropower system "Dabar" is designed to last as long as possible and to maximize economic effects during its exploitation. We can consider it in time i.e. during its life cycle. In literature (Bennett, 2003) the life cycle of construction is divided into next parts: pre-project phase, planning and design phase, contractor selection phase, project mobilisation phase, project operation phase and project closeout and termination phase. The life cycle of considered hydropower plant system "Dabar" could be, from geodetic aspect, divided in following periods:

- Period of design;
- Period of construction and

- Period of operation.

This simplification relative to the approach given in literature (Bennett, 2003) is possible because it includes the most of geodetic works and it also, as much as possible, simplifies the decisions for geodetic works organization.

According to the above facts it is obvious that hydropower system "Dabar" is complex system which requires a serious analysis in order to reach required efficiency and quality of geodetic works. Geodetic analysis shall include the all geodetic works needed through life cycle of hydropower plant system "Dabar" and to every location and any part of system, and to combine them in optimal way. Geodetic works also shall be scheduled according to the life cycle of system requirements and the resources for geodetic works shall be provided according to dynamic of system life cycle.

In geodetic sense (according to the authors' opinion) one constant shall be provided during the life cycle of hydropower plant system "Dabar" and that is the special geodetic networks which shall be established before project of system starting and shall last at least as long as the system operate. The geodetic 3D space in this case is separated in horizontal and vertical component, i.e. the horizontal and vertical geodetic networks were established in order to cover the need for geodetic measurement during the life cycle of hydropower plan system "Dabar". In following text the geodetic networks for will be described.

3 GEODETIC NETWORKS FOR HYDROPOWER PLANT SYSTEM "DABAR"

Geodetic networks for hydropower system "Dabar" were designed with aim to response to all requirements for geodetic data during the periods of its life cycle. Some of requirements could justify the utilization of existing State geodetic networks (for example: geodetic works of lower accuracy for topographic maps or for geologic and geophysics works) but special geodetic networks must be established and used for construction of any part of hydropower plant system "Dabar" because it's position and geometrical relationships are determined by technological and project parameters. Bearing in mind that derivative tunnel is approximately 12 km long the accuracy and reliability of geodetic data are of crucial importance. Following the complexity of system the geodetic 3D space is divided into horizontal and vertical component, i.e. the horizontal and vertical geodetic networks were established. This decision was made with presumption that vertical component is more important than horizontal (which of course is not irrelevant but it is easier to achieve the needed accuracy with contemporary available geodetic technologies) and that it is possible to achieve the greater accuracy for vertical component by using classical levelling than other technologies, regardless of the efficiency. These geodetic networks could be treated as geodetic networks of special purpose (Nestorović et al., 2011), of course respecting certain conditions of considered project.

3.1 VERTICAL GEODETIC NETWORK

Vertical geodetic network is consisted of 110 benchmarks spread over the area of hydropower plant system "Dabar". The vertical network is designed to cover area of hydropower system "Dabar" and to be a base for determining the heights of any object of it. This design provides heights of all objects in one unique vertical coordinate system. The field conditions determined the shape and the position of benchmarks. The Figure 2 shows the positions of benchmarks of vertical network relative to the tunnel of hydropower plant system "Dabar".

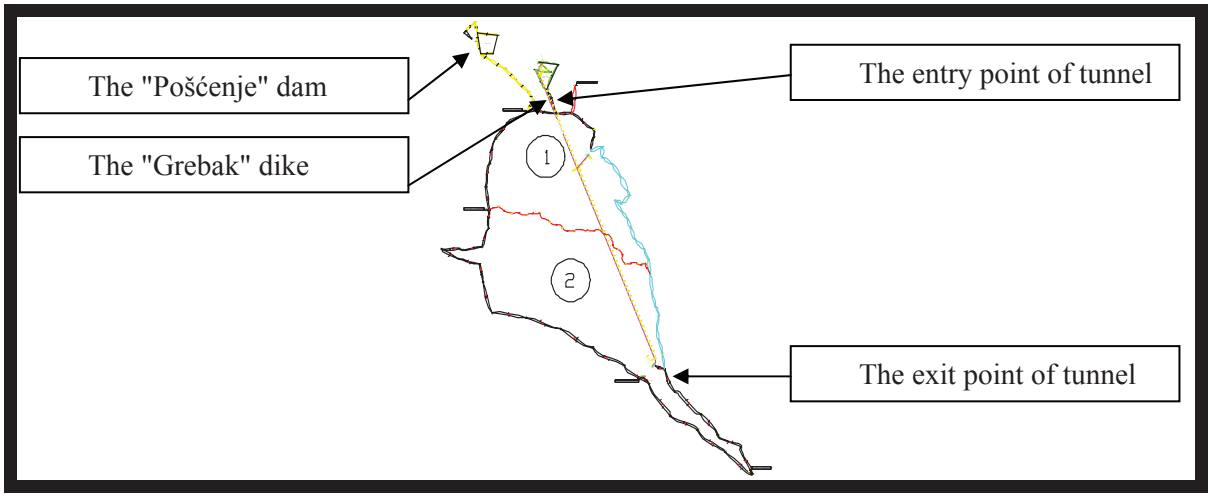

Figure 2 Vertical network of hydropower system "Dabar"

The length of levelling traverses is approximately 100 km because of terrain conditions and requirements that levelling lines shall follow the existing roads. Also the part of vertical network is designed to have two parallel close levelling traverses (black line on figure 2) in order to increase the reliability of results. The maximum height difference between benchmarks is approximately 500 m. The average length of traverse between two benchmarks is approximately 1 km, but between two close benchmarks in parallel traverses is up to 20 m. Measurements in vertical network shall be realized with accurate digital levels with bar coded levelling rods.

Benchmarks are stabilized in rock mass which shall provide long lasting position and stable heights, respecting the geological parameters.

3.2 HORIZONTAL GEODETIC NETWORK

The horizontal network for hydropower plant system "Dabar" is consisted of 12 points stabilized by concrete pillars founded on the stable ground and provided by precise mechanism for forced centring. Points of horizontal network are spread over the area of hydropower system "Dabar" in order to provide the base for all geodetic works and to meet all requirements in accuracy and efficiency of geodetic measurements during the life cycle of hydropower plant system "Dabar". Figure 3 shows the positions of horizontal networks points relative to hydropower plant system "Dabar". Because of the bed visibility and long distances between points it was decided that measurements in horizontal network shall be provided by GPS and, if possible, to use total stations for distance and directions measurements.

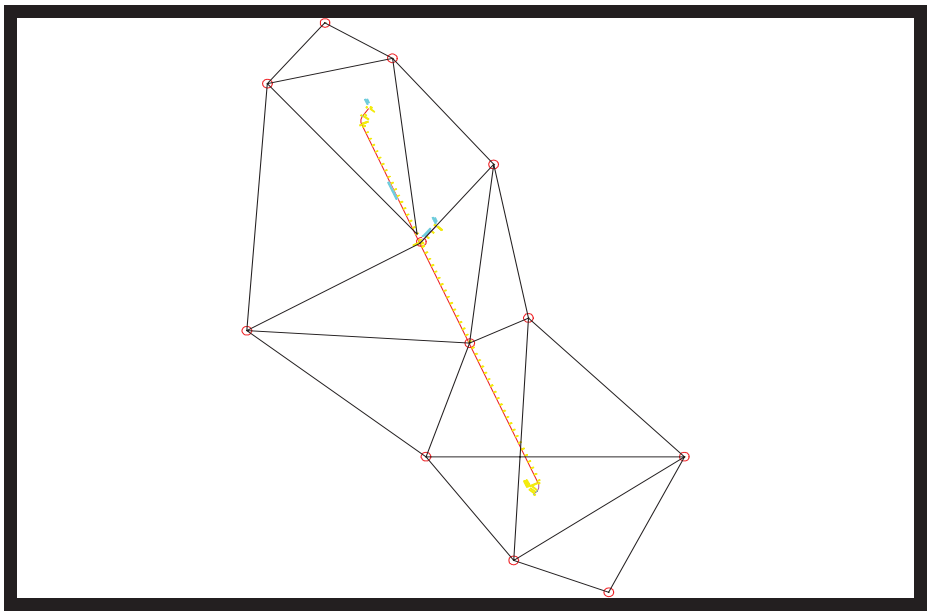

Figure 3 Horizontal network of hydropower system "Dabar"

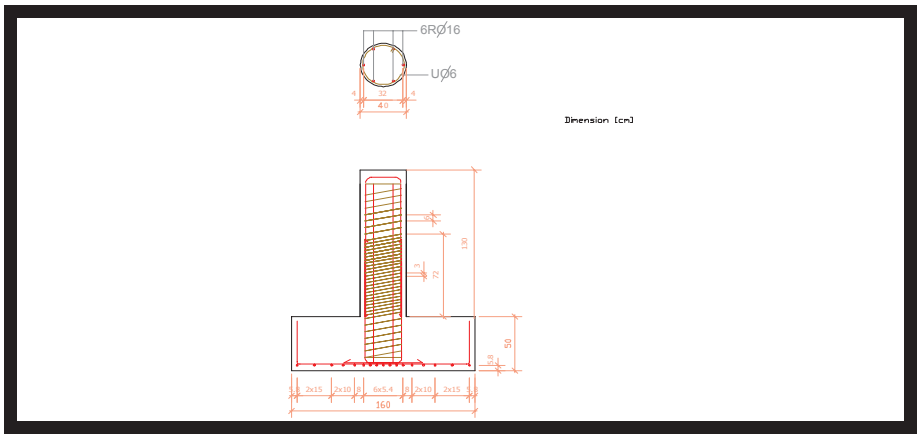

Figure 4 Construction drawing for pillars for horizontal network of hydropower system "Dabar"

Figure 5 Pillar for horizontal network of hydropower system "Dabar" in construction

The figure 4 shows the way on which the pillars are constructed and the figure 5 shows the picture of pillar with mechanism for centring.

4 CONCLUSION

The design and realization of geodetic networks for hydropower plant system "Dabar" shall provide the base of geodetic works during its life cycle because of:

- appropriate design and stabilization of points respecting the geological parameters and construction requirements and
- providing the measurements of appropriate accuracy in process of determination the coordinates and heights in networks.

Efficiency of geodetic works during life cycle of hydropower plant system "Dabar" is provided by density of the points and benchmarks, their assumed stability, long lasting and accuracy of their position.

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