TRACKING STABILITY OF ARCH DAMS THROUGH MICRO-TRIANGULATION METHOD

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Abstract. *In accordance with legal regulations in force, the objectives of hydropower (dams, hydroelectric plants, energy pumping stations etc.), it is necessary to make measurements and topo-geodetic surveying to produce documentation for the behavior of buildings (UCC). The purpose of these measurements and documentations is exploiting in safe conditions, according to the legislations, the hydro-technique objectives.*

Keywords: dam, triangulation, stability

INTRODUCTION

The behavior of energy building through surveying methods is an important component to ensure safe operation of hydropower objectives.

Geodetic measurements for the behavior of constructions covers two aspects:

- horizontal and vertical movements, which in many cases are very small, so that in certain circumstances they can be covered from the effects of inevitable errors that occur during the measurement;
- certain deformations that present an increased interest in terms of building safety.

A misinterpretation of results can lead to serious consequences affecting the security objectives.

If the track networks are stable and optimal set, measurement equipment can provide the required precision, in the case when the effectuated measurements are of high quality and the mathematical model used for efficient processing of land data is performing.This paper aims to track the stability of the Tarniţa dam made after a scheduled basis depending on: the season, atmospheric condition, the rate in the lake, etc. In Figures 1 and 2 are views of the area downstream and upstream of the dam.

Fig. 1. View of downstream

Fig. 2. Tarniţa Lake

MATERIAL AND METHOD

From the known methods of tracking the behavior of hydropower objectives was chosen the triangulation method.

The planimetry tracking network consists of 6 pilasters and 26 tracking marks located downstream of the dam on the parament.

In the paper are presented the movements of marks 26, 27, 28, 29, 31 located at the top of the downstream parament of the dam, in the central area (Fig. 3), where the water pressure and displacement are the largest.

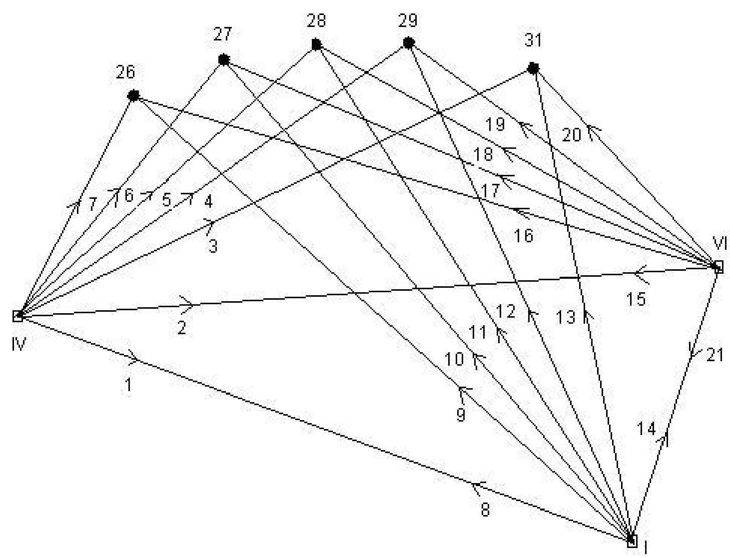


Fig. 3. Triangulation network

In general, the geometric construction of the micro-triangulation network must satisfy the main conditions of the triangulation of order I. (the angles must not be <33-35^g).

Also, to achieve the micro-triangulation, the ratio between the longest and the shortest side, it must not be below ¼.

The station points (pilasters) from which the observations for marks that are embedded in the downstream parament of the dam must be located on stable land, 4-5 in number, arranged so that the intersection visas to be> 30^g, and the level differences between stations and targeting marks will not be excessive.

Pilasters on which are alternatively installed the total stations and the targeting signals, are built of solid concrete and should be embedded in the bedrock (Fig. 4). At the top of the pilasters, after their concreting, is placed a special plate. To protect the upper parts of these pilasters, metal protection caps are positioned in the period in which there are no measurements.

Fig. 4. Pilaster with clamping device

Fig.5.Tracking mark

In order to perform observations on the horizontal plates, are alternatively placed the total stations and the signals to which are taken visas from other pilasters.

RESULTS AND DISCUSSION

Observations in micro-triangulation points were performed using the complete series method with 6-9 reiterations using a total station with 2^{cc} precision. The mean observations are presented in Table 1.

Table 1

Mean observations

Station	Visa point	Measured direction
	I	0,000500
	VI	374,726700
	31	350,179250
IV	29	341,444250
	28	331,197000
	27	319,831300
	26	305,002100
	IV	380,002400
	26	15,730250
I	27	26,651050
	28	37,732500
	29	50,448600
	31	63,807100
	VI	82,337150
	IV	13,411250
	26	49,950350
VI	27	59,764750
	28	70,574250
	29	84,929150
	31	103,961300
	I	341,020050

Data processing was done by indirect measurement method, matrix solved using Microsoft Excel software.

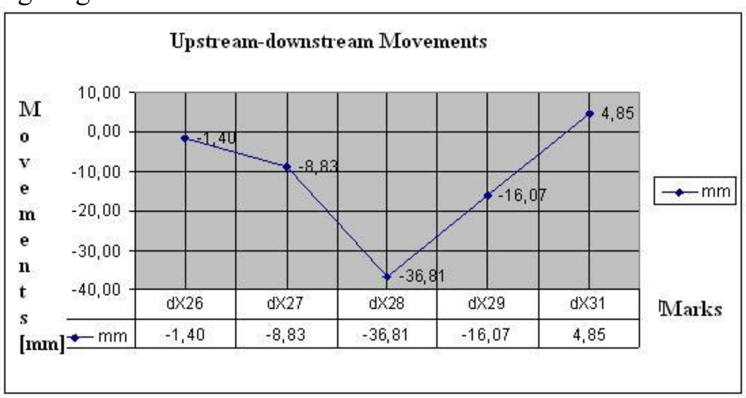
For micro-triangulation, the support network compensation was made as a free network obtaining an accuracy of about 2 mm. This precision results from the network configuration of pilasters, which ensure optimum angles in triangles. The network coordinates values are presented in Table 2.

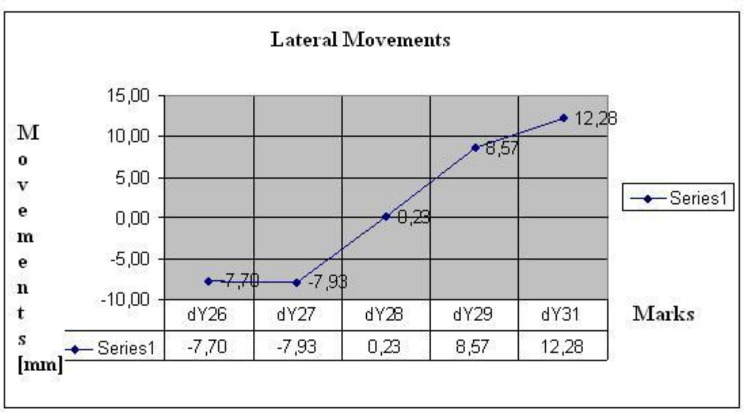
Table 2

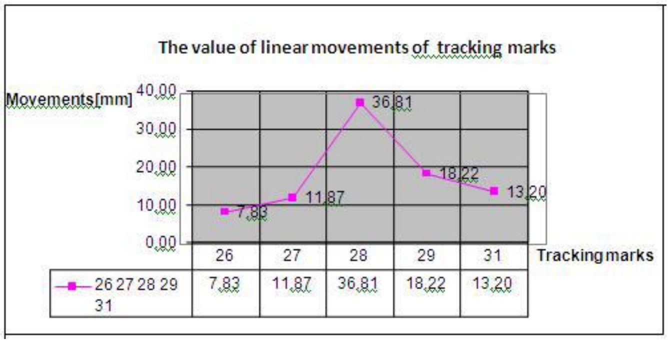
Micro-triangulation coordinates

Point	X [m]	Y [m]	Type
I	1028,5370	1246,6100	KNOWN
II	1031,5500	1131,9290	NEW
III	1093,9210	1149,2170	NEW
IV	1060,7160	1133,4750	KNOWN
V	1089,6630	1244,8990	KNOWN
VI	1076,2070	1262,0810	KNOWN

By making reports between the movement and the determination accuracy, were chosen as "fixed", points I, IV, V, VI, from which was compensated the complete network with tracking marks (Figure 5) obtaining an accuracy of about 2 mm . After the calculations were obtained the tracking marks values, presented in the following diagrams.







To determine the accuracy of measurements and calculations were calculated the ellipse parameters errors of the tracking marks. The parameters values are presented in Table 3.

Table 3

Ellipse parameters errors

Tracking marks	Sx [mm]	Sy [mm]	St [mm]	a	b	θ
26	1,1826867	0,8377252	1,45	0,0264738	0,0186734	9,375993
27	1,0951432	0,9498009	1,45	0,0248613	0,0207942	389,91105
28	1,1391901	0,957735	1,49	0,0282775	0,0191693	361,98616
29	1,3068673	0,847677	1,56	0,0335253	0,0166309	42,654247
31	1,5942353	0,6124803	1,71	0,0425614	0,0145667	23,842633

Following the diagram of downstream – upstream movements and of linear movements, it appears that the movement of mark 28 is bigger than all other marks, which is practically impossible, given the construction of concrete dam.

Given the error ellipse for mark 28, the unauthorized high movement of the point was due to previous coordinates coordinates, towards it is established the movement in current stage.

CONCLUSIONS

Given the current network configuration of the micro-triangulation, some tracking marks cannot be followed under favorable angles, negatively influencing the accuracy of determination, or even their determination.

In general, the accuracy of determination are close to those imposed by UCC methodology and specifications for the design, execution and processing of measurements on existing buildings.

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