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ACCURACY OF PRELIMINARY DATA OBTAINED FROM TOPOGRAPHIC PLANS FOR THE DESIGN OF HYDRAULIC STRUCTURES

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ABSTRACT: In this article, creating a topographic plan of the reservoir, determining the horizontal values of the reservoir in terms of height, establishing radial networks of the reservoir using the closed polygon method, determining coordinate values by installing receivers, and determining connecting points.

KEYWORDS: GNSS, GPS, GLONASS reservoir, dam, topographic map, signals, satellite, geoietrie polygon.

INTRODUCTION

One of the most difficult tasks for a surveyor is to evaluate the results of observations. This is especially important in satellite technology compared to traditional methods of tracking angles, ranges, and deviations, because in this method the tracking technique itself does not appear as an overt physical factor. The specialist must have dimensions based on the complete equipment, in which there is no doubt that this equipment is working properly and that it meets the specified requirements.

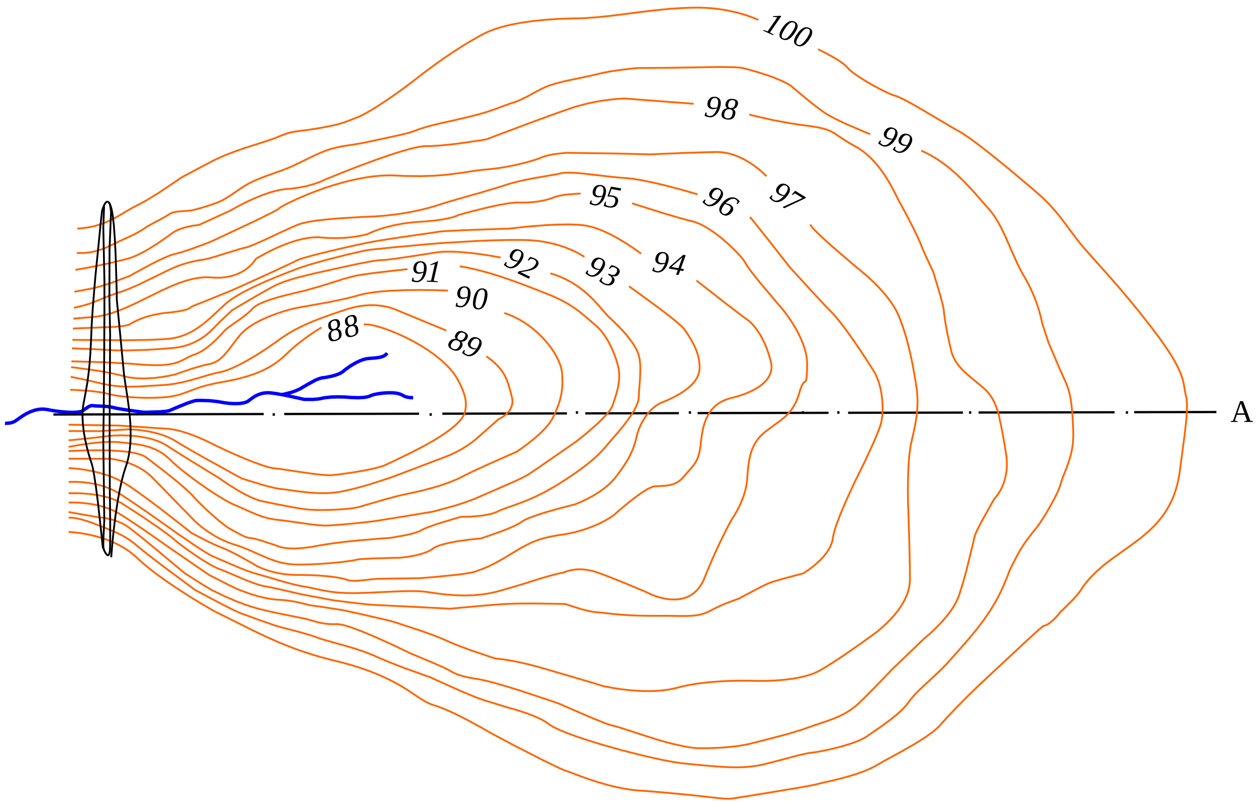
4 main factors that cause errors in GLONASS/GPS technology, like normal geodetic observations, can be shown:

- observer's error (incorrect measurement of antenna height, errors in center alignment, errors in meteorological equipment indicators);
- hardware errors, including errors related to phase and code calculation, hardware interference, satellite and receiver timing errors, errors related to their delivery, center deviation in antenna phases, etc;
- factors of external influence on the signal distribution paths (non-uniformity of the tronosphere and ionosphere, multipaths, interference, influence of magnetic storms, etc.).

The problem. Mathematical analysis errors (errors in the movement of satellites in the geometry of the constellation, errors related to baseline a priori coordinates and orbits, errors related to geophysical or stochastic models).

The satellite coordinates are calculated based on the geocentric coordinate system at a specified time interval. During the time of signal transmission from the satellite to the receiver, the receiver moves slightly due to the rotation of the Earth. Taking into account that the signal transmission time is approximately 0.07÷0.08s, if the earth moves by an angle of ~1.5 during this time, the signal receiving apparatus moves 40÷50 mg. The distance between variable objects refers to the length of the section connecting two points on the object's trajectories.

Analysis. In engineering, in particular, the study, design and construction of hydraulic structures rely on the initial information obtained from topographic plans, the quality of which is largely related to accuracy (Figure 1).



1- fig. Topographical plan of the reservoir basin

The accuracy of topographic plans in planned relationships is characterized by the mean square or the average error of the position of the contour point on the plan with respect to the nearest points of the survey base. There is a relationship between the root mean square and mean errors of the contour point position on the plan.

$$m_t = 1{,}06v_t \text{ or } m_t \approx v_t \qquad (1)$$

The height accuracy of topographic plans is characterized by the mean square tn or the mean square error in determining the horizontal plan of point heights relative to the nearest points of the base of the survey. It is necessary to take into account the formula for calculating the accuracy of large-scale surveys with a normal distribution of errors m_n and the following relationship.

$$m_n = 1{,}25\mathrm{v_n} \qquad (2)$$

The theoretical value of the mean square error of the horizontal position in height can be calculated by the formula of N.G. Viduev.

$$m_h = 0{,}19h_0 + 16 * 10{-}5^{-5} M_o i_{\text{ўр}} \qquad (3)$$

here h_0- relief the height of the part, M_o- the denominator of the numerical scale of the plan, $i_{\breve{y}p}$ the average slope of the land.

$$m_t = 1{,}06\ v_t\ \ yoki\ \ m_t \approx v_t \qquad (4)$$

The accuracy of the position of the contour point on the plan depends on the errors of drawing the reference points of gravity and graphic operations on the plan. With the circular distribution of coordinate errors, i.e $m_x = m_y = m_0$ error rate when the coordinate errors of point contours are root mean square m_t can be expressed by the formula.

$$m_t = m_0\sqrt{2} \qquad (5)$$

Here m_0 root mean square error of coordinates.

It is necessary to measure distances and directions between contour points when preparing preliminary data for moving the project to its location and solving other engineering problems.

In this case, the horizontal flow S between contour points can be determined by the following formula.

$$S=\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \qquad (6)$$

where x_1 and x_2, y_1 and $y_2$respectively, the abscissa and ordinate of the vertices are defined as lines, graphics.

The mean square error m_s of the line S, provided that the mean square errors of the position of the ends of the line m_{t1} and m_{t2} are equal and the coordinates are not related to each other.

$$m_s = m_t \qquad (7)$$

When shooting developed areas, m_t = 0.3 mm and the maximum error is Δ_t=2m_t=0.6 mm. The direction angle of a line between contour points is calculated as follows.

$$tg\alpha = (y_2 - y_1)/(x_2 - x_1) \qquad (8)$$

For contour points $m_{t1} = m_{t2} = m_{to}$, mean square error of angle with uncorrelated coordinates

$$m_\alpha=\frac{m_t}{p}s \qquad (9)$$

It follows from the formula that the greater the distance between the points of the contour according to the plan, the more accurate the direction angle.

Therefore, the points of the geodetic base should be in the initial direction when connecting the design of the structures of reclamation systems. When having the longest length, m_t=0.3 mm, S = 200 m according to the formula $m_a=5^1$.

The maximum error in determining the direction angle is expressed as follows.

$$\Delta_a = 2m_a = 10^1 \qquad (10)$$

During the design process, as well as when calculating the networks of hydrotechnical structures, planning works and calculating the volume, excess and slope of the lines are determined according to the plan.

$$H = H_2 - H_1 \qquad (11)$$

If the mean squared errors of the heights are assumed to be “equal” and their determination errors are uncorrelated, the excess mean squared error will be.

$$m_h = m_H\sqrt{2} \qquad (12)$$

i the slope is calculated according to the following formula

$$I = \frac{H_2 - H_2}{S} \qquad (13)$$

The mean square error i is calculated on S when determining the slope.

$$m_i = \frac{m_H\sqrt{2}}{S} \qquad (14)$$

However, at distances less than l_{max} between the pickets, the mean square error plus (12) and slope (13) should be calculated using the appropriate formulas.

$$m_h = m_H\sqrt{2}(2 - r_H \qquad (15)$$

$$m_t = \frac{m_H\sqrt{2}(1 - r_H)}{2} \qquad (16)$$

Here r_H- correlation coefficient of point heights.
If we S=0.4 l_{max} according to the calculation tables, m_h = 0.13 and r_h = 50, so that the calculation of the root mean square error is obtained by the coefficient i=0.020.

$$m_i = 10i\ \% \qquad (17)$$

Least squares allowed us to derive empirical formulas that express the dependence of relative errors on the scale and height of the water relief part in the reservoir when calculating the volume of reservoirs.
One of the most important elements of water management calculations is:
- determination of area and volume;
- solving problematic morphometric characteristics of the reservoir using a table;
- determining the filling mode and emptying the reservoir.

The level of reservoirs, characteristic of the height of the water level in the reservoir, is obtained from the horizontals in the reservoir basin (Fig. 2), first the flooded areas, and then the volumes of the prisms of different levels.

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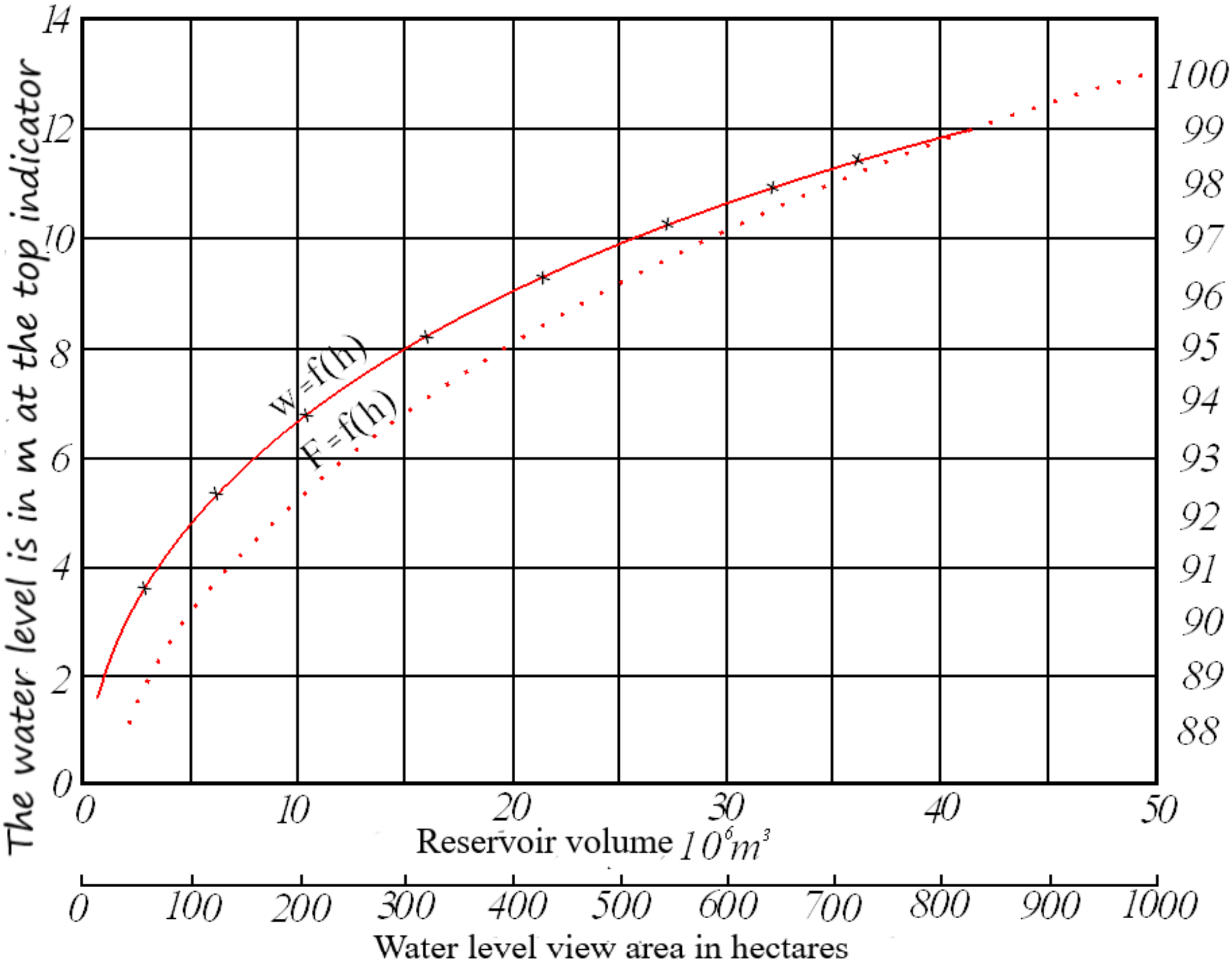

Figure 2. Histogram of the dependence of the area F and the volume W on the 11th level

In the process of processing measurements obtained as a result of observations of high-resolution satellites, it is necessary to take into account all the factors that affect the accuracy of observations, and to take into account the methods of determining the characteristics of these factors. Based on the characteristics of the influencing factors, the errors can be divided into 2 groups: systematic errors and noise-random errors.

One of the most difficult tasks for a surveyor is to evaluate the results of observations. This is especially important in satellite technology compared to traditional methods of tracking angles, ranges, and deviations, because in this method the tracking technique itself does not appear as an overt physical factor. The specialist must have dimensions based on the complete equipment, in which there is no doubt that the equipment is working properly and that it meets the specified requirements.

Result. When constructing a network of closed geometric shapes, vectors between the network points should be defined in such a way that they should form closed polygons (Fig. 3).

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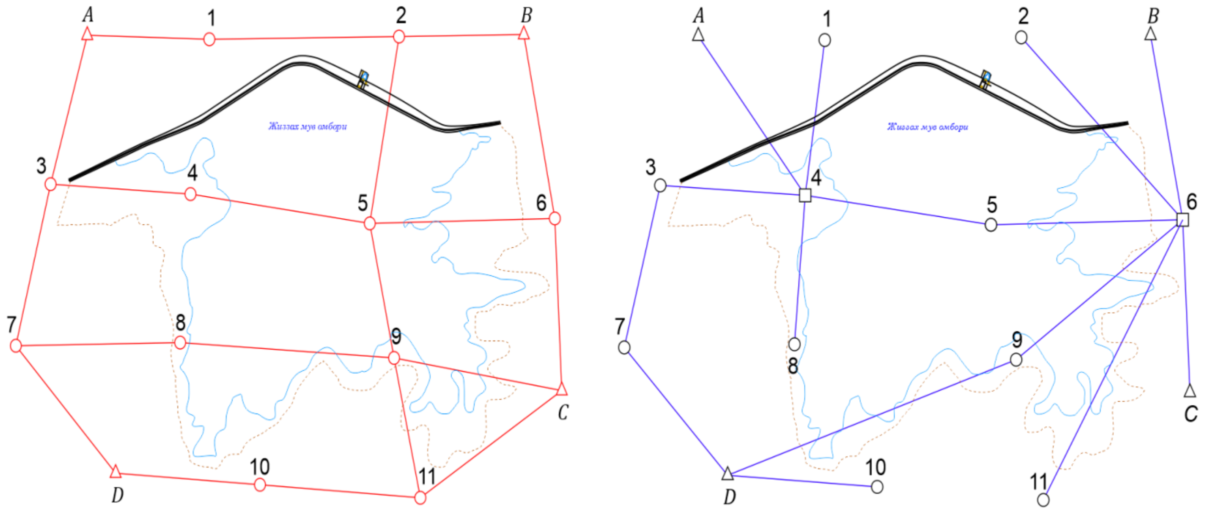

3 – fig. Closed geometric polygons and radial networks

△ - *Starting points*

□ - *Points to be determined*

○ - *Reference stations*

The design of the planned geodetic network is based on the selection of the method of satellite measurements, the function of the network and its accuracy. The following requirements are taken into account in order to ensure satellite measurements when choosing the location of the planned network points:

1. There should be no source of strong radio waves near the point (up to 1-2 km).;
2. There should not be an obstacle with a height of more than 15° above the horizon around the point;
3. Long-term preservation of the point center;
4. Convenient access to the point at any time and working conditions.

When designing a network in closed geometric forms, it is necessary to take into account the need to determine the position of each point from the measurement of two vectors that are not related to each other. In this case, it is not allowed to get a spatial vector. In a longitudinal network, the need to interconnect network endpoints should be considered for monitoring measurements.

In the design, it is necessary to provide re-measurement of vectors of not less than 50% of the vectors determined in state 3 and 4 class compression networks.

The graphic part of the project is made on a topographic map, which shows the starting and determining points and the location of reference stations.

The minimum number of sessions required to calculate the coordinates of points in the static method is determined from the following formula.

$$S = \frac{P - O}{N - O}, \qquad (18)$$

where R is the total number of points in the network, O is the total number of points in sessions, N is the number of receivers.

For example, in the network shown in Figure 4, when P=16, N=4 and O=1, we find from formula (1) S=5 (in the calculation, the fractional value is added as one). The drawing of the installation of the receivers is given in Fig. 4.

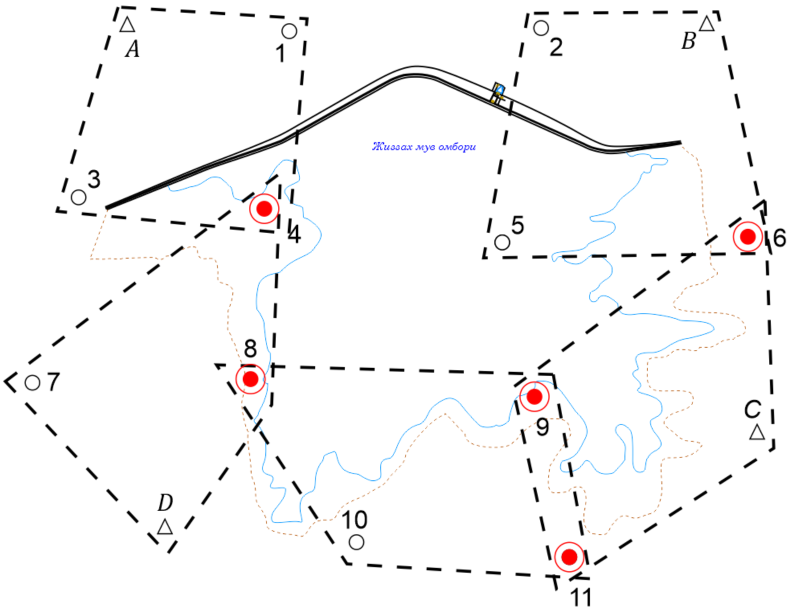

Figure 4. Scheme of installation of receivers

If the model network being designed consists of rectangles, the number of attempts is calculated according to the following formula:

$$S = \frac{2 \cdot P - \sqrt{P}}{N - 1}, \tag{19}$$

formula for calculating the number of vectors to be measured in a network

$$V = S \cdot (N - 1), \tag{20}$$

formula for calculating the number of rectangles in a grid

$$F = V - P + 1 , \tag{21}$$

here V - number of vectors to be measured, F - the number of rectangles in the grid.

At the station, work begins with the installation of the antenna. In this case, the tripod on which the antenna is installed is firmly fixed on the ground, and the antenna is centered on the center of the point with an accuracy of ±2 mm using an optical sharpener. The height of the antenna is measured twice at the beginning and at the end of the observations using a tape measure or other device. If the difference of these results does not exceed 2 mm, they are averaged. Antenna height measurement error negatively affects the accuracy of determined coordinates (X, Y, Z).

Turn on the receiver, perform measurements and turn off the receiver according to the user manual. At the beginning of the measurements, the working tasks of the receiver are checked. Tracked satellites are shaped by the angle of inclination, recording interval, recording retention and free memory size. The recording interval must be the same for all receivers working together. After the receiver is turned on, it must be ensured that it is tracking the required number of satellites and calculating the coordinates of its location. Before starting the attempts, the point name, antenna height, operator code and other necessary information must be entered into the receiver. During the research work, entries are made in the field journal.

CONCLUSION

When constructing geodetic networks using satellite measurements, a scheme for installing receivers was developed based on a closed geometric polygon and radial networks. As a result, re-measurement works in the 3rd and 4th class compression networks were reduced to a value of not less than 50%.

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