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METHOD FOR BUILDING A WORKING GEODETIC NETWORK OF REFLECTIVE MARKS FOR CONSTRUCTION NEEDS

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Abstract: *The work in the implementation of construction works for large production buildings, residential complexes, airports, sports complexes, examination of deformations and many other activities that require precise geodetic measurements can be optimized during and quality through the creation and use of geodetic reflective marks. The article discusses how to stabilize and measure the working base and part of the processing theory.*

Keywords*: working geodetic basis*

In order to start the implementation of an investment project, whether area or line, it is necessary to have a good geodetic base, such that it is accessible by the engineers – surveyors at any time in the construction process and provides the intended accuracy of execution. It is imperative that we always check what source data we have from the working base before proceeding to tracer work or geodetic photographs for execution purposes. In projects developed by part geodesy, output points and work points are usually given through which to carry out the works, very often, however, these points cannot cover the service of the entire construction site. For this, it is necessary to design and thicken new points. The thickening of the working network is carried out according to the familiar classical methods triangulation, precise polygonometry and less often trilateration. In a settlement, triangular methods are almost impossible for working points stabilized on the ground. The opportunity to build a good triangulation is when stabilizing the points of massive high-rise buildings.

For this, most often in an urban environment proceed to the thickening of the working base by precise polygonometry. Depending on the area on which we need to develop our points and the distance between them, polygon moves are designed by class. From the beginning, a main polygon is made, and then all additional polygons are included in it. Most often, when creating the main polygon for the site, the work points provided by the designer by part of geodesy or by the approved cadastral map are used. The new points will be defined in different classes and with different accuracy. This is a prerequisite for the stakeout of the sites of the locality with different accuracy, which in precise geodetic works is unacceptable. It is necessary to specify with what accuracy and we will need to have to perform the specific site [1].

The tools with which we will carry out measurements must be checked and meet the following conditions:

1. The line of sight of the optical/laser plummet should be along the vertical axis.

2. The trunnion axis should be perpendicular to the vertical axis.

3. The line of sight through the intersection of the crosshairs (called the line of collimation) should be perpendicular to the trunnion axis.

4. The line of collimation should pass through the trunnion and vertical axes.

5. The horizontal and vertical crosshairs should be parallel to the trunnion and vertical axes respectively.

6. When the instrument and alidade bubble are levelled, and the line of collimation is horizontal, the vertical angle should read exactly 0º, 90º, or 270º (depending on how the instrument is configured).

7. For convenience in setting up, the horizontal plate bubble should be central when the vertical axis is vertical. These points can be checked and permanent adjustments can be made to all of them. (All these adjustments are called ‘permanent’ to distinguish them from the ‘station’ adjustments, which are made every time instrument is set up.) As well as the requirements listed above, there are others which cannot be adjusted.

8. The horizontal circle should be perpendicular to the vertical axis, and the vertical circle perpendicular to the trunnion axis.

9. The center of the horizontal circle should coincide with the vertical axis, and the center of the vertical circle with the trunnion axis.

10. The circles should be accurately graduated.

11. There should be no backlash [2].

All survey results are based on measurements and all measurements are subject to errors. Since the study involves a high degree of accuracy (most study measurements are accurate to 10 parts per million, and some are within 2 parts per million), it is relatively easy to make mistakes and relatively difficult to detect. Therefore, understanding and managing errors is perhaps the most important skills that a professional surveyor must possess. Many of the research techniques are aimed at cancelling or eliminating errors and ensuring that there are no serious error remains undiscovered in the final result. However, the presence of unnoticed "systematic" errors in the poll can lead to false but seemingly consistent results. A recent international tunneling project deviated a few meters from the intended road because the temperature gradients near the tunnel wall caused the laser beams to bend, and this was not detected until an independent method of checking the work was used.

High accuracy in the study is expensive because it includes expensive and high quality equipment and more complex measurement procedures. On the other hand, cheaper equipment may not be sufficient to achieve the necessary accuracy, especially if the (e.g.) the long distance must be divided into several steps, which requires more measurements and leads to accumulation of errors. Therefore, studies are often conducted by using high-quality equipment to establish several "main control" stations in the area with higher accuracy than necessary as a whole and then filling in the intermediate workpiece of the cheaper methods suitable for shorter distances. This is usually the most economical way of allocating the 'error budget' in order to achieve a minimum satisfactory final result [3].

The calculation of the coordinates of the new work markers is by parametric alignment of the two stations jointly by the method of the smallest squares, each mark being determined by straight geodetic tasks, linear detect, straight-line.

Equals line. First, determine the directional angles from the three given points to the new ones by formula:

(1) $$tg\alpha_{ik} = \frac{y_2 - y_1}{x_2 - x_1}.$$

Calculate the indicative unknowns and measured directional angles to be used in the alignment, considered to be measured dimensions:

(2) $$\alpha ik - Rik = Oik',$$

(3) $$Rik - Oi = \varphi ik.$$

The weights shall be calculated:

(4) $$P\varphi = \frac{s}{s+1}.$$

For equations of fixes in general, we will have:

(5) $$Vik = aik.dx + bik.dy + fik.$$

Average square error per unit of weight:

(6) $$m_e = \pm\sqrt{\frac{[pvv]}{n-2}}.$$

After drawing up and solving normal equations, an accuracy analysis shall be carried out. If the resulting accuracy of the new points satisfies, the required trace accuracy is ready to proceed to the workflow [4].

Modern technologies, and in particular the entry of laser measurements over distances (prismless distance measurements), make it possible to optimize certain processes related to the way construction sites are stakeout and how construction networks are designed and measured. The development of a geodetic network of marks allows each of the trace stages to be carried out with ease without the need for the preliminary stakeout of the main axles, which will subsequently serve to trace subsequent stages.

The geodetic network of brands is done in order to facilitate the work of the survey engineer and optimize the workflow. It usually needs to be built, if necessary to continuously conduct geodetic measurements in the construction works of production buildings, halls, residential complexes, sports complexes, airports, stadiums and examination of deformations. For stakeout specialized structural elements, lines of machines that must be precisely positioned, specialized construction equipment and with an accuracy of the order of 2-3 mm. Geodetic photographs for checks of the achieved accuracy, executions.

The positives at work are that the network can be used simultaneously by an unlimited number of geodetic teams at the same time without getting in the way. Errors from centering of the instrument, inaccurate placement of reflective instruments on ground points, inaccurate measurement of instrument height are eliminated. Orientation time is increased many times, since physical crawling of orientation points is not necessary, but is always started from a free station.

In order to be able to take advantage of the above positives, we need to have checked and calibrated instruments with no less accuracy of 3" for horizontal angles and 2 mm + 2 ppm and the possibility of prismless measurement at a distance of 250 – 300 m. An important condition is that the geodetic instrument has software for calculating a free station and equalizes the results by the method of the smallest squares of the measurements in real time and the operator is always aware of the accuracy and the station from which the stakeout works will be carried out.

Order and way to build the network.

Reflective marks Fig. 1 and Fig. 2 are now relatively easy to find at companies offering geodetic equipment. Special plastic stands can be found through which the angle can be changed in orientation.

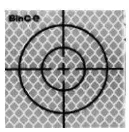

Fig. 1. Reflective mark

Fig. 2. Reflective mark on plastic stand

When building a geodetic network of reflective brands in an urban environment, some of the most suitable places for placing brands are apartment blocks, high production chimneys, reinforced concrete poles from the electrical grid. The points are evenly distributed radially around the construction site (working area) if possible over distances not more than 300 m from the site. Depending on the surface of which the work mark will be attached, construction adhesives may be used, but it is important that the choice of glue or other fastener is not affected by weather conditions, as marker offset may be caused due to overheating by the sun's rays. Markers should not be measured immediately on the day of their gluing and stabilization.

Once we have reflected the new brands of the locality, they must be measured and calculated. The measurement of the marks must be carried out from at least three working points from the pre-built main polygon, selecting the points with the lowest average square errors of x, y and h. The tool is positioned sequentially at all three selected points and measurements are made to the new work marks in one or at the discretion of two girus. For orientation, only the points which we have previously determined as output are used. After processing the girus and calculating the coordinates of the new points for each station, an analysis of the results is made. The coordinates of the newly defined work marks defined by the first one are used. The second and third station must not exceed the average errors at the starting points.

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