Horizontal Survey of Crane Paths

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ABSTRACT

In general, the term deformation refers to a change in the shape of the observational object. In geodetic practice, it is accepted consider deformation as a change in the position of the object relative to of any original provision.

KEYWORDS: *deformation, observations, geodetic, change, distance, subcrane, polygonometry.*

INTRODUCTION

One of the most difficult and time-consuming processes in observing precipitation and deformations of buildings and structures located on the territory of the Barnaul TETs-2 was horizontal and vertical survey of crane tracks. This is caused by significant temperatures observed at the locations of the crane tracks, a large movement of air masses, which leads to significant refraction. In addition, under the conditions of operating workshops, strong vibration occurs due to operating turbines and mechanisms. All the listed environmental factors present during operation in the operating machine and boiler rooms of the Barnaul TED-2 significantly affect the geodetic work carried out to determine the geometry of the crane tracks, and lead to a sharp loss of the necessary measurement accuracy. Under these conditions, to ensure the specified accuracy of geodetic measurements, it is necessary to reduce the maximum permissible line of sight.

Object study

According to our research carried out in the existing workshops of the Barnaul TED-2, the maximum distance from the tool to the sighting target can be allowed:

a) for turbine generator shop not more than 70 m

b) for boiler room not more than 100 m

In that case, the use of known methods of observing the displacement of engineering structures from the alignment does not provide the desired accuracy and productivity of work. We propose to determine the straightness of the crane tracks not by measuring small angles (as shown in Figure 1), but by laying a polygonometric stroke along the rail string (see Figure 2).

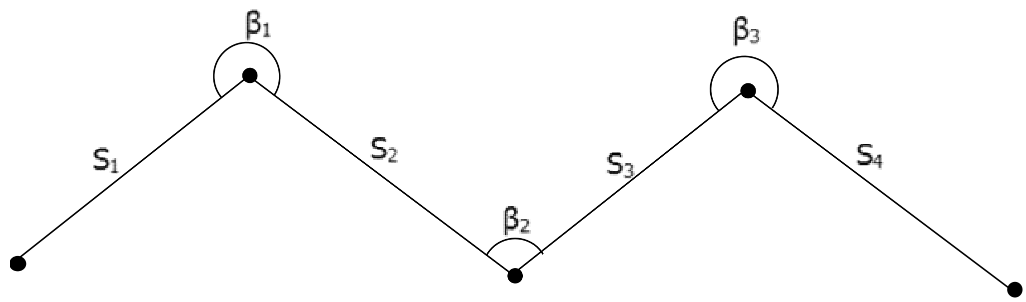

Figure 1

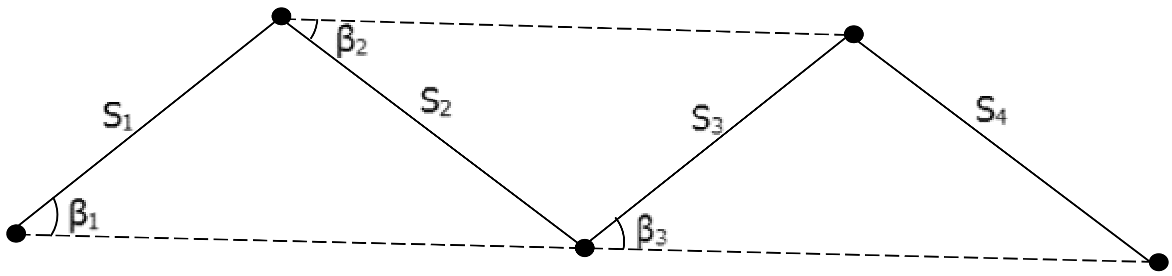

Figure 2

As can be seen from the above figures, the inventive method, all other things being equal, reduces the line of sight as compared to conventional methods by half. In addition, errors caused by refocusing of the visual tube of theodolite are excluded. These provide a process of mathematical processing of measurement results. It should be noted that for the first time such a method of observing non-solubility was applied by B.N. Zhukov when observing deformations of the Sayan-Shchushenskaya hydroelectric station. Previously, it was obtained that the mean square error of determining non-solubility should not exceed ± 3.3 mm. Outcome from this admission it is determinable maximum permissible errors of measurement of corners and lines to the offered technique for definition of geometry of subcrane ways in BTETs-2 halls.

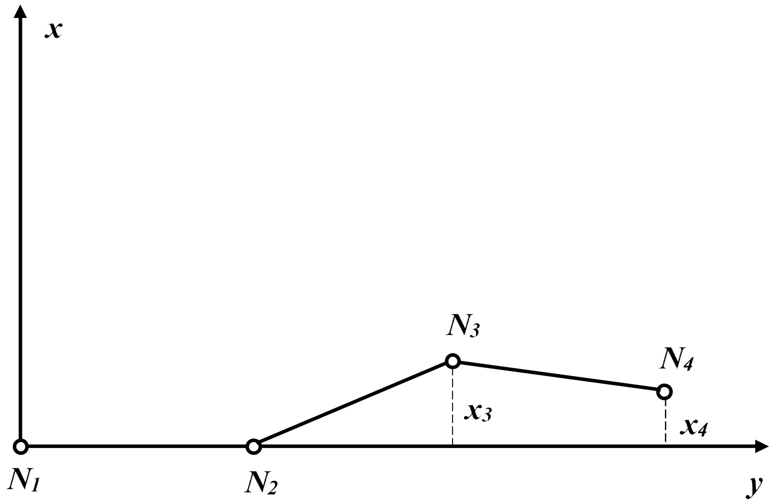

Figure 3

Based on Figure 3, it is possible to write (assuming α=˜ 90 °):

$$\Delta X = S\cos\alpha \qquad (1)$$

Let's spread this expression into a Taylor series and limit ourselves to the terms of decomposition

$$\Delta X = \frac{S\alpha''}{\rho''} \qquad (2)$$

We produce this expression according to the variables and.

$$d(\Delta X) = \frac{S}{\rho''}d\alpha + \frac{\alpha}{\rho''}dS \qquad (3)$$

Replace differentials with mean quadratic errors

$$\left(m_{(\Delta X)}\right)^2 = \left(\frac{S}{\rho''}\cdot m_\alpha\right)^2 + \left(\frac{\alpha}{\rho''}m_S\right)^2 \qquad (4)$$

In formula (4) m_α, the average quadratic error of the directional angle can be expressed by the formula

$$m_\alpha = \pm m_\beta \sqrt{n} \qquad (5)$$

where m_β is the mean square error of the measured angle

n - number of stations

substituting an expression into a formula, we get

$$\left(m_{(\Delta X)}\right)^2 = \left(\frac{S}{\rho''} \cdot m_\beta \sqrt{n}\right)^2 + \left(\frac{\alpha}{\rho} \cdot m_S\right)^2 \qquad (6)$$

where S - is the distance between the defined points

ρ″ - number of seconds in radian

m_S - mean quadratic distance measurement error.

Applying the principle of equal influence and setting the limit error

$$m_{\Delta x} = 3.3mm$$

we will receive

$$m_{(\Delta X)} = \frac{S}{\rho''} \cdot m_\beta \sqrt{n}$$

$$m_\beta = \pm \sqrt{\frac{{m_{(\Delta X)}}^2 \cdot \rho^2}{S^2 \cdot n}} = \pm \frac{3.3 \cdot 200\,000}{70\,000} \sqrt{\frac{1}{3}} = 4.9'' \qquad (7)$$

therefore, in the proposed method of determining angles, it is necessary to measure the error not exceeding 5.5

$$m_S = \pm \sqrt{\frac{m_{(\Delta X)^2} \cdot \rho^2}{\alpha^2}} = \sim 2\text{метра} \qquad (8)$$

Thus, the basic error in determining non-solubility is caused by errors in angular measurements, so the lack of control for the measured angles negatively affects the quality of the work performed. To eliminate this drawback, we propose to lay a closed polygonometric stroke along both legs of the crane tracks (as shown in Figure 4)

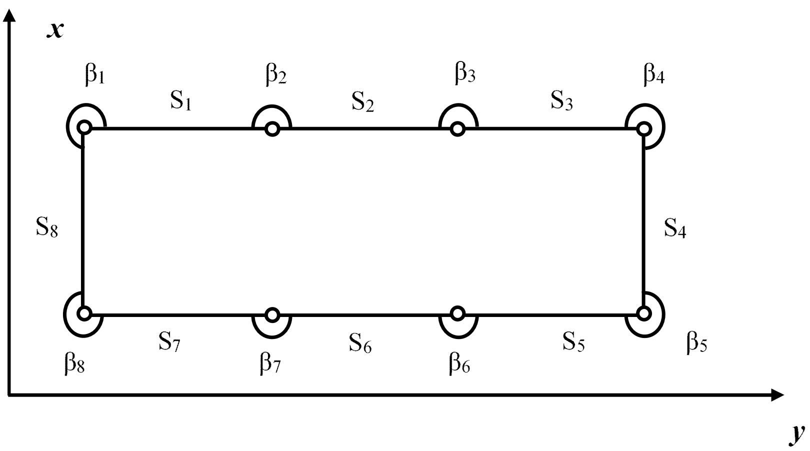

Figure 4

With this trimming, the quality of the angle measurement can be controlled using an angular misalignment calculated from the formula

$$f = \sum_{i}^{n+1} \beta_{лев} - 180° \cdot n \qquad (9)$$

where n - is the number of angles,

$\beta_{лев}$ - measured left angles of rotation.

You must set a valid angular misalignment, which can be calculated using the formula

$$f_{доп} = \pm 2.5 \cdot m_{\beta}\sqrt{n} = \pm 2.5 \cdot 4.5\sqrt{10} = \pm 34'' \qquad (10)$$

The further processing process is to calculate and separately equalize the closed polygonometric stroke. By setting the direction angle of the side 1-2, 90° we can directly obtain non-voids on series A and B in one common system. In addition, the quality of measurements in determining non-solubility can be judged by the transverse non-binding $f_{\Delta X}$, the limit value of which can be calculated by the formula

$$f_{\Delta X пред} = \pm m_{нест} \cdot \sqrt{n} \qquad (11)$$

where $m_{нест}$ - is the mean quadratic error in determining the non-solubility of i point, n is the number of points to define.

$$f_{\Delta X пред} = \pm 2.5 \cdot 3.3 мм\sqrt{10} = \pm 31 мм \qquad (12)$$

The limit value of the transverse misalignment in relative measure should not be coarser before the calculated relative error of the line measurement. Consider the error with which you need to center theodolite and sighting targets in the proposed method of determining non-solubility. Using the known formula of geodesy, we obtain

$$m = \frac{m_{ц}\rho''}{S} \qquad (13)$$

where $m_{ц}$ - is error of theodolite centering using optical plumb,

S - is the smallest side of the polygonometric stroke,

m - is the measurement error of the angle caused by the misalignment of the theodolite.

By setting the value of m equal to half of the mean square error of the measured angle m_{β}, we calculate $m_{ц}$.

$$m_{ц} = \frac{m \cdot S}{\rho''} = \frac{2.2 \cdot 70\,000}{200\,000} = \sim 1 мм$$

Thus, the accuracy of the alignment of the tool and sighting devices above the rail head should be no more than ± 1 mm, which can be ensured by the use of an optical plumb in the operation. By obtaining the equalized coordinates of points from the polygonometric stroke, you can calculate the equalized distances between the defined points using the following formula:

$$S^* = \frac{S_n \cdot P_1 + S_{изм} \cdot P_2}{P_1 + P_2} \qquad (14)$$

where S_n - is the distance obtained between points at equalized coordinates;

$S_{изм}$ - measured distance;

P_1 - weight of distance obtained by coordinates;

P_2 - is the weight of the measured distance.

According to the studies carried out in the conditions of operating workshops BTETs-2 the ratio between weights is determined by the following formula

$P_1 = 2 \cdot P_2$ (15)

Calculating the difference between the equalized distances and those calculated by the formula

$\Delta = S_{выч} - S_{ур}$ (16)

It is possible to obtain by formula 17 the equalized deviations of rail axes from the target on both strands of crane tracks

$\alpha_{A_{урав}} = \alpha_A - \frac{\Delta}{2}$

$\alpha_{Б_{урав}} = \alpha_Б + \frac{\Delta}{2}$ (17)

where α_A - evasion from the target along the frame A;

α_B - evasion from the target along the frame B.

The accuracy of the obtained results can be estimated according to the formula 18

$m_\alpha = \pm\sqrt{\frac{(P\Delta\Delta)}{n-1}}$ (18)

where Δ are according to formula 16

n number of measured distances.

For the camera processing of the results of the planned survey of crane tracks, we compiled a program in the Fotran-4 language with further implementation on the 1022 series of computers. The completed program allows you to completely automate the process of camera processing of the results. This program consists of three main parts. In the first part, the intervals are processed to obtain the non-voids of the frame points, which are then used as starting points in calculating rail evasions from the target throughout the column. The program provides processing of the measurement results made to determine the non-solubility of the crane tracks either according to the proposed method, or according to the method proposed by (6), or by the classical method of partial or sequential targets.

The second part of the program provides for the processing of materials that allow to obtain non-solubility throughout the column and such evasions of the beam axes from the sash.

In the third part of the program, using a graph builder, a plot of crane lines with a drawing design is drawn.

Conclusion

The planned survey of crane tracks in the boiler room No. 1 BTETs-2 was carried out in 3 ways:

1) by the method of successive slats,

2) methods for measuring horizontal angles proposed by Zhukov B.N.

3) by the method proposed by the authors of this report.

The accuracy of the work performed was evaluated according to the formula 18.

The results of the accuracy assessment are placed in Table No. 1

Table 1.

Characteristics of the observation method	Mean square error of equalized dodges, mm.
1	± 12,1
2	± 7.5
3	± 5.4

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