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Analysis of the influence of the atmosphere surface layer on the measurement made by electronic total stations

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ABSTRACT: The paper analysis the influence of the atmosphere surface layer on the measurements made by electronic total stations. It is shown that the account of the influence of the atmosphere should be designed for the simultaneous introduction of amendments both in the angle and in the linear measurements, especially in the measurements of vertical angles.

KEYWORDS: electronic total stations, the atmosphere surface layer, geodetic production, electronic theodolite, climatic conditions.

I. INTRODUCTION

At the present stage of scientific-technical progress electronic measuring equipment is widely used in the geodetic production. In the age of the advanced computer technology, there is no need for physical calculations and drawings-all makes by a computer with the appropriate software. To perform a site service as soon as possible with the results as accurate as possible will help an electronic total station, a universal geodetic device. In an electronic theodolite, reading is removed automatically by using a special device [4]. This device is a glass disk the angular values are recorded there on in the form of a system of nontransparent hatchings or in a system of code paths and converted into an electronic signal. The disk is illuminated by the light beam; when you turn on the theodolite, a signal is generated on the photo-receiver in a binary code, which after decoding is displaced on the scoreboard in a digital form.

II. TEXT DETECTION

The electronic total station is a combination of an electronic theodolite, a small-sized phase of the light rangefinder and microcomputer into a signal structure. If you compare the work with a theodolite and a total station, then in the first case, it is necessary to record in the register journal, in the second case, it is necessary to record only contour(outline) and data on the distances, angles and numbers of pickets, the device will record and store in the memory. When the location of the geodetic device is changed, it is necessary to set only the new station and the first picket and then direct it to the reflector and then get the calculated total station measurements only by pressing one button. Speaking about the universality of the electronic total station, it should be noted that what is traditional for geodesy division of measuring equipment on range-finding and angular-meter it is not applicable to this device. One bringing the total station on a view finding target point, the role of which the reflector plays, allows to measure the horizontal direction, a vertical angle and a distance. The presence of the built-in micro-computer in the device provides its versatility and operativeness. Software of the most modern total stations allows to carry out the following steps in the field conditions [2]: to take out in nature coordinates and lines; to decide the reverse mark; to determine the hight of an inaccessible object, to determine inaccessible distance, to project the point on the line, to calculate squares. The instrument accuracy of modern high-precision total stations is 0,5"and (1mm+1mm/km) and the range of action is 5km. High accuracy,

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operativeness and versatility make the electronic total station as an indispensable device in solving the most geodetic tasks - from creating networks of condensation to staking out work.

It should be noted, that universality of the total stations which is shown above creates great in comparison with traditional geodetic measurements difficulties when accounting the influence of the atmosphere.

The method for determining distances by an electronic total station is not different from the traditional methods of an electronic range-meter. The mechanism and the degree of the heterogeneity of the atmosphere surface layer on this type of measurements are as follows: the distance D is determined from the measured signal propagation time τ along the distance in the forward and backward direction [5].

$$D = \frac{\vartheta\tau}{2}, \qquad (1)$$

in assuming that the speed of radiation propagation ϑ is known. In heterogeneous environments the speed ϑ changes from one point of trajectory to another one. For the accurate determining of the resulting values for the path speed, it is necessary to know the average integral along the route of the refractive index $\langle n \rangle$

$$\langle n \rangle = 1/D \int_0^D n dx, \qquad (2)$$

where, n-refractive index value at the current point of the trajectory. Determined by the formula (1), the distance will contain an error for the accepted difference when calculating the speed ϑ of its value averaged along the route. The error depends on the degree of variability of the air layer along the route i.e. from the gradient of the refractive index in the direction of radiation spread. It should be noted that the angular refraction also distorts the results of the distance measurements by refractive extension of trajectory, but the effect of this factor is insignificant, and later, when mentioned about the influence of the atmosphere inhomogeneity on the accuracy of linear measurements we will mean only the change of propagation speed of radiation.

As to angular measurement, the geodetic theodolite and electric total station are different in the way of information and their technical implementation. The character and degree of the influence of the atmospheric boundary layer on the results of angular measurements when using electronic total station, they remained the same, when moving the telescope of the total station to the reflector, the trajectory of the sight beam undergoes changes in heterogeneous environment due to the presence of the gradient refractive index in the plane, normal to the beam path.

III. EXT INPAINTING

It follows that the heterogeneity of the atmosphere surface layer between the device and the reflector effects on the results of the measurements, performed by the electronic total station in two ways: on one hand-changing the signal propagation velocity leads to a distortion of the measured distances, on the other hand–angular measurements include an error for the influence of the angular refraction. When geodetic surveying service requires high precision and is performed with the help of the electronic total station, then it becomes necessary to take into account the influence of the atmosphere on the measurements results. The main advantage of the total station which consists in possibility of processing the results of measurements in the field, but they can be reduced to zero the need to consider the influence of the atmosphere. Here comes the task of the operational conducting of amendments for the influence of the atmosphere in all the results of measurements. Such decisions involve the development of a set of measures, including the methodology for taking into account the effect of the atmosphere and the appropriate software.

IV. EXPERIMENTAL RESULTS

The technology of taking into account the influence of the atmosphere should be designed for the simultaneous amendments both in the angular and the linear measurements. Particular attention should be paid to the accuracy of vertical angles measurement. The horizontal refraction at distances of several kilometers in length has a significant value in the case of the pronounced heterogeneity of the underlying surface in the direction, perpendicular to the sighting plane. The angular of the vertical refraction on the track with the length of 5km may reach 200"[3].The values of the angle of the vertical refraction is equal to (30-40)" on the track with the length of 1, 3 km, passing over the steppe surface are observed in summer almost every day. The measurement of the angle inclination with the error of (30-40)" will lead to the error in determining the excess, which is equal to 20cm. A large variability of the vertical gradient of the refractive index leads to the worsening of the problem. For the two adjacent tracks, passing over the

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water and the surface of the steppe on a moment time, the difference in the angle of refraction can be up to 1' [1].The complexity of the accounting effect of the atmosphere on the accuracy of definition, excluding by the method of trigonometric leveling, at present remains almost the only reason for which it is necessary to resort to a more accurate and more time-consuming geometric leveling.

V. CONCLUSION

Summarizing all the above-mentioned, we can conclude that the influence of the atmospheric boundary layer effects all types of geodetic measurements. In some cases, it is more in others, and it is less in anotherones the upper layers of the atmosphere affectlonger on the accuracy of some types of measurements, the further increasing the accuracy of others depends entirely on the effectiveness of the account of the influence of the surface air layer. Geodetic and engineering-geodetic tasks, requiring measurements of high accuracy cannot be solved without the involvement of the accounting methods of the atmospheric effect. The development of the effective methods of calculating, the effect of the atmospheric boundary layer is impossible without the knowledge of the nature of the refraction phenomenon, laws of formation of fields of the refraction index in various climatic conditions.

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