AUTOMATED MEASUREMENT WITH ELECTROOPTICAL DISTANCE METER AND PRECISE DISTANCE MEASUREMENT PROCESSING AT THE CALIBRATION BASE OF THE FACULTY OF GEODESY IN ZAGREB

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Abstract – The paper describes the method of setting the parameters in the instrument Leica TC 2003 before going to the Calibration base for the purpose of automated precise distance measurement. Software has been developed for the automated distance measurement data processing for seven pillars of the Calibration base. In data processing there are standard deviations of measured distance mean values obtained from the measurement forward and backward. After the processing and adjustment of measured values, definite pillar ranges are obtained, as well as the addition correction. Apart from that, there are standard deviations of distance mean values from the measurements forward and backward computed depending on the distance, then standard deviations in determining the pillar ranges and standard deviations in determining the addition correction. This automated measurements and the processing of measured data will enable regular periodical adjustment of the Calibration Base of the Faculty of Geodesy, University of Zagreb, in accordance with the Book of Rules on Standard maintenance.

Keywords: Calibration base, standard adjustment.

1. INTRODUCTION

Pursuant to the Law on Measurement Activity [1] and to the Regulation about measuring instruments that the measurement surveillance is performed for [2], as well as to the Regulation about the periods in which standard adjustment is to be made and certification periods for repeated instrument certification [3], the certification period for the repeated standard adjustment is one year. So far we have succeeded to adjust our calibration base (standard) every ten years, and not every year as we are supposed to. We have had no precise electro optical distance meter, or automated measurement data processing at the Calibration base. At the Faculty of Geodesy a new precise electro optical distance meter Leica TC 2003 [4] was bought in 2002 having the accuracy of 1mm + 1ppm according to manufacturer information. Our experience in measuring at the Calibration base have indicated that it is much more precise as related to the similar but older model of the distance meter Leica TC 2002. With precise measurement of atmospheric parameters the standard deviation of distance measurement with TC 2000 amounted for the distance of 900 m 0,25 mm) [5]. Our measurements at the Base with TC 2003 from 2006 have also shown that this instruments provides average standard deviations of distance mean values from the measurements forward and backward, and after the adjustment of distances, s_a = 0,12 - 0,000 0003·D [mm/m], where D is the length in meters [6]. Since the precise electro optical distance meter Mekometar ME 5000 is not produced any more, we have decided to develop automated procedure of precise distance measurement with Leica TC 2003 for the adjustment of pillar ranges at our Calibration base [7], [8], [9], [10] and [11], and to automate the procedure of processing adjusting the measured data by means of a software.

2. LABORATORY TESTING OF DISTANCE UNIT IN THE INSTRUMENT TC 2003, BEFORE THE MEASUREMENT ON THE CALIBRATION BASE

Before the measurement on the calibration base, the frequency meter has to be calibration in the laboratory with GPS signal [12], and then the frequency is to be measured in the distance meter [13], [12] and calculate the multiplication constant for the distance meter. At the Calibration base the periodical error is to be determined before adjusting the pillars (the paper on this topic will be published soon in Geodetski list).

3. SETTING THE PARAMETERS IN THE ELECTROOPTICAL DISTANCE METER LEICE TC 2003 BEFORE THE MEASUREMENT ON THE CALIBRATION BASE

In order to perform and record the measurement at the Calibration base automatically, it is necessary to do the following in the software of the electro optical distance meter Leica TC 2003:

- delete the data on the memory card,
- adjust the exact time in TC 2003 because the atmospheric parameters will be entered later on the basis of time,
- set up the functionality,
- set up the communication parameters,
- select the main menu,
- in *user template* select the units and decimal number, set the recording mask and display mask,
- set up the distance meter to precise operation mode,
- enter the prism type into the instrument,
- set the air temperature to 0,0 °C, air pressure to 1013,3 mbar and total ppm to 0,0. These instrument parameters will remain the same during the whole measurement time on the Base. During the distance measurement time, the atmospheric parameters are measured at several places on the base, and afterwards, at the time of data processing, the atmospheric influences are calculated.

After setting the parameters into the instrument, the prism needs to be set up, a few distance measurements done, then check whether the display indicates the necessary data, and check whether these data are saved, which can be checked in the menu DATA, and submenu SEARCH.

4. PRECISE MEASUREMENT OF DISTANCES WITH ELECTROOPTICAL DISTANCE METER TC 2003 ON THE CALIBRATION BASE

After setting the parameters into the instrument, before the beginning of the measurement itself, the number of pillars is entered into the instrument, i.e. the station of the instrument.

At the Calibration base of the Faculty of Geodesy, at short distances up to 100 m, the pillars have got the designations as shown in the table 1:

Table 1. Designations on pillars and distances between them.

Pillar designation	distance
11A	0 m
10A	2,5 m
9A	5 m
8A	7,5 m
7A	10 m
6A	20 m
5A	30 m
4A	40 m
3A	50 m
2A	70 m
1A	90 m
0A	100 m

At long distance up to 3000 m the pillars have got the designations as shown in the table 2:

Table 2. Designations on pillars and distances between them.

Pillar designation	distance
0	0 m
1	100 m
2	200 m
3	300 m
4	400 m
5	500 m
6	600 m
7	700 m
8	800 m
9	900 m
10	1000 m
11	1500 m
12	2000 m
13	3000 m

In order to process automatically the data saved in the instrument, and if in the distance adjustment only 7 pillars are used, then the number for the instrument station should be entered in the following way.
Instead of the pillar designation, one of the numbers between 1 and 7, i.e. the number of pillar, should be entered out of the total of seven pillars where the measurement will be made.

After entering the number of instrument station, the number of pillar is entered with the prism on it. After the pillar number with the prism on it, the letter A is added.

In order to achieve as high precision and accuracy of distance measurement as possible, it is recommended to do the measurement on cloudy days, and atmospheric parameter measurement should be paid special attention. During the measurement of distance the air temperature is read with aspirated thermometer with the accuracy of 0,1 ºC at the instrument station and near the prism, with the thermometer placed in the level with instrument objective. At the electronic meteorological station Thommen – Meteo Station HM30 the air pressure is read with the accuracy of 0,1 mbar and the humidity with the accuracy of 0,1%,. Along with these data the time of reading is entered into the filed book. During the temperature measurement, and when transporting the thermometer from one point to another, the thermometer needs to be protected from direct sun rays. The measurement of atmospheric parameters would be done very carefully, because the error in temperature measurement of 1 ºC has got the influence of 1 mm at the distance of 1000 m, and the change of air pressure of 3 mbar, has got the influence of 1 mm as well. These are really large mistakes, especially if we take into consideration, that the standard deviation in precise distance measurement at the Calibration base amount up to 0,1 mm at 1000 m. The automation of measurement and saving the atmospheric parameters is planned during the adjustment of Calibration base, with the meteorological station of the firm Vaisala.

After performing the measurements at the Calibration base, the data are transmitted in the laboratory from the electro optical distance meter into the computer.

5. AUTOMATED PROCESSING AND ADJUSTMENT OF DANA FROM PRECISE MEASUREMENTS AT THE CALIBRATION BASE

During the course at the postgraduate studies within the scope of the seminar work, a software support has been developed for automated measurement data processing at the Calibration base in Microsoft Visual studio. NET environment. After retrieving the data from the files with measurements, the additional data about temperature, pressure and humidity should be entered manually from the field book. The automated method of transferring the atmospheric parameters collected in the field will soon be developed with the help of the meteorological station Vaisala, directly into the computer.

After that, the reductions of measured distances are calculated automatically out of the mean distance valued measured forwards and backwards, then average standard deviations of measured mean distance values are calculated and presented graphically from the measurements forwards and backwards depending on the distance as shown on Fig. 1.

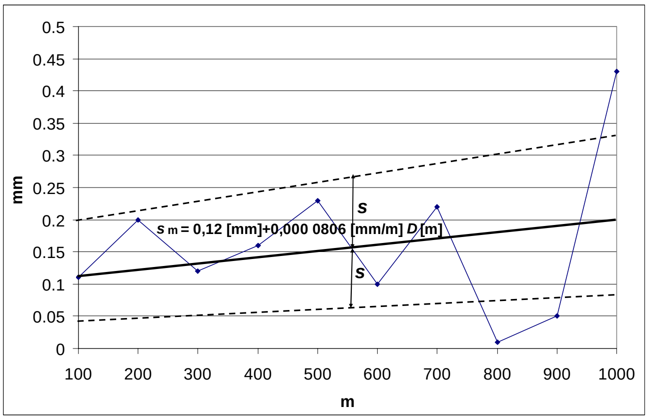

Fig. 1. Average standard deviations of mean distance values from the measurements forwards and backwards

Then all pillar ranges are automatically adjusted on the Base and the definite pillar ranges and addition correction are obtained. Apart from that, the average standard deviations of the measured mean distance values are calculated depending on the length after the adjustment and graphically presented. After standard deviations in determining the pillar ranges are calculated and presented graphically as well (Fig. 2), the standard deviation in determining the addition correction is calculated.

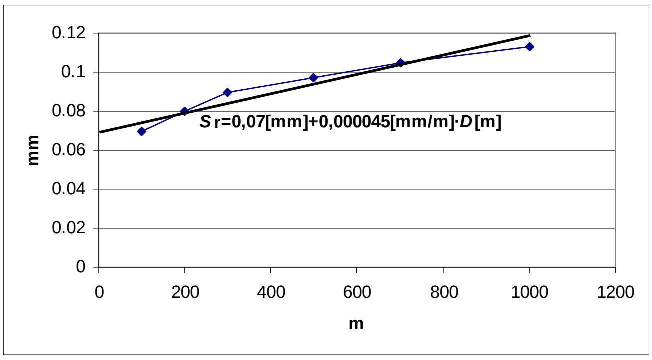

Fig. 2. Standard deviations in determining the pillar ranges from the fist pillar depending on the length

5. CONCLUSION

The automation of precise distance measurements and measurement processing at the Calibration base of the Geodetic Faculty in Zagreb will make it possible to adjust the pillar ranges at the Calibration base for testing and adjustment of electro optical distance meters periodically. According to the Regulations about the periods for repeated adjustment of distance standard [3], such adjustments should be done once a year. Thus, the stability of the Calibration base is tested and controlled, whereby possible movements of individual pillars are recorded and reference values of the ranges between them determined.

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