Buletinul Ştiinţific al Universităţii "POLITEHNICA" din Timişoara

Seria HIDROTEHNICA
TRANSACTIONS on HYDROTECHNICS

Tom 55(69), Fascicola 1, 2010

Posibilities of selecting the equipment and method in plotting operation

***Doandeş Victor** ***Popescu Daniela**

Abstract:The issue of enclosing the outcome of plotting a construction within the admitted tolerance in the field requires to prior determining the precision of the equipment and consequently the right selection of the proper devices.

Keywords: tracing, methods, equipment, errors

1.GENERAL

The issue of enclosing the results within the admitted tolerance has to be addressed in the case of tracings, regardless they are in the horizontal plane or in the vertical plane.

The accuracy of tracing depends on several factors, most important of which refers to the equipment and the working method that are used.

For this reason, verifying the apparatus and rectifying it if necessary, and also selection of the equipment based on an analysis of calculations taking into account the errors that might appear, are necessary.

For determining accuracy in use of equipment will take into account a number of standards: ISO 8322-1 (effective from June 1, 1995): Civil constructions. Measuring tools. Methods for determining accuracy in use> Part 1: Theory

The complete series contains the following parts:

-Part 1: Theory ... SR ISO 8322-1

-Part 2: Measuring tapes .... SR ISO 8322-2

-Part 3: Optical instruments for leveling ... SR ISO 8322-3

-Part 4: Theodolites ... SR ISO 8322-4

-Part5: Optical instruments for elevation ... SR ISO 8322-5

-Part 6: Laser Tools ... SR ISO 8322-6

-Part 7: Instruments for plotting ... SR ISO 8322-7

-Part 8: Tools distance measuring up to 150 m. .. SR ISO 8322-8

All these standards refer to the experimental methods adopted for determining and assessing the accuracy in use of the measuring tools for civil constructions.

2. A PRACTICAL CHOICE OF SELECTION THE EQUIPMENT FOR TRACING

Example 1: To determine the parameters of plotting a horizontal angle knowing

that the plotted direction will be marked by a point N situated approximately 50 m from the bearing point, and the difference of level $\Delta H_{AN} = 4$ m şi $E_w \leq 1^c$

Resolution:

Centering the device on the bearing point will be performed with the optical centering system and for the point of orientation a centered optical target sighting will be used. Marking point must be made with +/- 2.5mm accuracy.

If use a small precision tachymeter, this device does not meet the demands of precision required.

If use tachymeter THEO 0-20 (.....), will result: ....., this device meets the required precision demands. Average tilt angle ….. , applying relationship:

$\varepsilon_c^2 + \varepsilon_y^2 = E_0^2 - \varepsilon_G^2 - \varepsilon_v^2 = 999,82 - 100 - (6 \cdot 0,087)^2 = 899,55$;

severe will be checked and, if not met, the device must be rectified.

Example 2. To determine the tracing parameters of a horizontal angle, given distance D = 100m, $\varphi_{max} = 10^g$, $E_w \leq 30^{cc}$

assuming: $\varepsilon_c = \varepsilon_y = \varepsilon$, will result : $\varepsilon = 21,20^{cc}$.

$k \leq \varepsilon \cos\varphi = 21,13^{cc}$;$i \leq \varepsilon \operatorname{ctg}\varphi = 269,3^{cc}$;

Condition $i = 269,3^{cc}$ is satisfied generally, but condition $k = 21,3^{cc}$ being more

[1]Faculty of Hydrotechnical Engineering Timisoara, CHIF Department, George Enescu Str. No. 1/A, 300022 Timisoara, E-mail: victordoandes@yahoo.com, danna_popescu@yahoo.com

Resolution:

a.) telescope in one position

$$E_0 = \frac{30}{\sqrt{10}} = 9{,}49^{cc} \ ;$$

$$e_c = e_s \le \frac{D.E_0}{\rho^{cc}} = \frac{100000.9{,}49}{636620} = 1{,}49mm \ .$$

Center should be done with optical centering device, very carefully (optical centering device should be checked and corrected, if necessary). For precision tachymeter THEO – 010 A (M= 30, p = 0,5^{cc} and s=20$^{''}$), will result:

$$E_3 = \sqrt{\left(\frac{200^{cc}}{M}\right)^2 + \left(\frac{p}{2}\right)^2} = 6{,}68^{cc} < E_0 \ ;$$

$$E_4 = \sqrt{\varepsilon_G{}^2 + \varepsilon_c{}^2 + \varepsilon_v{}^2 + \varepsilon_y{}^2} = \sqrt{\left(10^{cc}\right)^2 + \varepsilon_c^2 + \left(4^{cc}.0{,}1583\right)^2 + \varepsilon_y^2} > E_0 \ ;$$

$E_5 = 15^{cc} > E_0$, accuracy cannot be achieved by tracing with telescope in only one position.

b.) with telescope in both positions, with tachymeter THEO – 010 A

Starting from known values: $\varepsilon_i = \varepsilon_v = \varepsilon_y = 0$; $\varepsilon_G = 10^{cc}$;

$E_3 = 6{,}68^{cc}$; $E_5 = 15^{cc}$, will result: $E_w{}^2 = 2E_2{}^2 + 2E_3{}^2 + 2\varepsilon_G{}^2 + 2E_5{}^2 + 2E_1{}^2$;

$2(E_1 + E_2) = E_w{}^2 - 2E_3{}^2 - 2\varepsilon_G{}^2 - 2E_5{}^2 = 160{,}75$; $E_1 = E_2 = 6{,}33^{cc}$; $e_c = e_s = \pm 1$ mm .

Tracing can be done with telescope in both positions, paying particular attention to the centering point and to the signal at the orientation point (centering with optical device and targeting point)

Example 3: a.) To determine the tracing parameters of a lift knowing that the distance between the holding point and the point path is 200m, and the mean error $E_{\Delta H} \le 10$ mm.

Resolution:

a.) tracing by means of geometrical levelling from the midle ($E_S = E_i = 0$) :

Key characteristics of the device will determine the selection with the condition:

$E_C = E_0$ şi $E_N = E_0$

$$E_{\Delta H} = E_0.\sqrt{12} \rightarrow E_0 \le \frac{E_{\Delta H}}{\sqrt{12}} = 2{,}89mm$$

$$M \ge \frac{10^{-4}.D_p}{0{,}25.E_0} = 13{,}8X \quad ; \quad S^{cc} \le \frac{10.\rho^{cc}.E_0}{D_p} = 184^{cc}$$

Selecting a device that satisfies these conditions (e.g. NI-030 which has M=25X şi S=30$^{''}$) will result the follwing values for the accidental errors:

$$E_C = \frac{10^{-4}.D_p}{0{,}25.M} = 1{,}6mm \quad ; \quad E_N = \frac{S^{''}.D_p}{10.\rho^{cc}} = 1{,}45mm \ ;$$

$$E_F = 5.10^{-6}.D_p = \pm 0{,}5mm \quad ; \quad E_R = \pm 0{,}5mm \quad ; \quad E_D = \pm 0{,}25mm \ ;$$

$$E_{\Delta H} = E_S + E_i + \sqrt{2(E_C^2 + E_N^2 + E_F^2 + E_R^2 + E_D^2 + E_m^2)} = \sqrt{8{,}87 + 2E_m^2} \rightarrow$$

[1]Faculty of Hydrotechnical Engineering Timisoara, CHIF Department, George Enescu Str. No. 1/A, 300022 Timisoara, E-mail: victordoandes@yahoo.com, danna_popescu@yahoo.com

$$2E_m^2 = E_{\Delta H}^2 - 8{,}87 \Rightarrow E_m \leq 6{,}75mm \Leftrightarrow$$

Tracing conditions are fulfilled if marking provides an accuracy of ± 6,75 mm, which is practically easy to achieve.

b). By geometrical levelling

$$E_{\Delta H} = E_0.\sqrt{12} \rightarrow E_0 \leq \frac{E_{\Delta H}}{2+\sqrt{12}} = 1{,}83mm$$

Determine the device characteristics:

$$M \geq \frac{10^{-4}.D_p}{0{,}25.E_0} = 43X \quad ; \quad S'' \leq \frac{10.\rho''.E_0}{D_p} = 18{,}8''$$

The proper device should be NI-004 (M = 44X, S = 10 ‘’) which for, will result the following values of component errors:

$$E_C = \frac{10^{-4}.D_p}{0{,}25.M} = 1{,}82mm \quad ; \quad E_N = \frac{S''.D_p}{10.\rho^{cc}} = 0{,}96mm \ ;$$

$$E_F = 5.10^{-6}.D_p = \pm 1{,}0mm \quad ; \quad E_R = \pm 0{,}5mm \quad ; \quad E_D = \pm 0{,}25mm \ ;$$

$E_S = \frac{D_p^2}{2R} = 3{,}13mm$, assuming that the device was checked and verified

ε = 10’’, will result Ei = ± 1 mm and we’ll have : $E_{\Delta H} = 3{,}13 + 1 + \sqrt{11{,}09 + 2.E_m^2} \rightarrow E_m = \pm 5{,}9 \quad mm$

in terms of accuracy the difference of level can be traced by geometrical leveling from the end, requiring, for this purpose, a high precision instrument which complicates the operation of tracing. It is recommended tracing by mean geometrical leveling with even lenghts (or approximately even, within the limits of difference of 2-3 m).

3. CONCLUSIONS

Selecting the tracing method depends on:

- the nature of the plotted object;
- dimensions and shape of the construction
- conditions to make measurements (heavy terrain, with obstacles, crossing water, at high altitude, etc.)
- distance between the standing points and the points that have to be plotted;
- required precision for the new points positioning;
- the equipment available;

Depending on the situation on the ground, always choose the easiest method in order to ensure the accuracy required.

4. REFERENCES

[1]. Doandeş Victor, Topografie, Ed.Politehnica, Timişoara, 2008

[2]. Robert C.Vernon, Profesional Surveyor’s Manual, McGraw-Hill,1997

[1]Faculty of Hydrotechnical Engineering Timisoara, CHIF Department, George Enescu Str. No. 1/A, 300022 Timisoara, E-mail: victordoandes@yahoo.com, danna_popescu@yahoo.com