GEODETIC TEST FIELD
FOR CERTIFICATION OF GEODETIC DEVICES

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ABSTRACT

The establishment of the scientific geodetic test field consisting of: 1) the fundamental geodetic network for the metrological certification of GPS receivers, and 2) geodetic baseline for metrological certification and testing geodetic instruments for linear measurements are described in the paper. The point coordinates of geodetic network are determined with the accuracy of few millimeters and the stability of the geodetic basis of about 1 mm.

1. INTRODUCTION

Metrological certification of geodetic devices should be made on geodetic test basis. For GPS receivers certification and verification should be made on the geodetic test network.
In Institute of Geodesy at the National University Lviv Polytechnic there was established a multifunctional scientific geodetic test field (Trevoho I.S., et. al., 2010). This Yavoriv test field was created with the following aims:

- **for certification and testing of GPS receivers;**
- **to develop methods and study concerning the accuracy of GPS-levelling;**
- **to study changes of the gravitational field to make models of the geoid in local regions, needed for GPS-levelling;**
- **for certification and verification of light and laser rangefinder, electronic total stations, laser roulette and traditional surveying tools and techniques of linear measurements;**
- **for experimental studies of methods of metrological control of geodetic instruments and measurement technologies;**
- **for preservation of the length of geodesic lines of the basis of the 1st category (standard accuracy - (0,6 +1 10-6*D*) mm (Trevoho I.S., et. al., 2010)) using precise geodetic measurements;**
- **for development of operational methods of metrological control of the stability of points and lines of the geodesic basis using satellite technology.**

Structure of geodetic test field includes two metrology objects, namely (Fig. 1):
1) the fundamental geodetic network for testing instruments and GPS receivers;
2) test line of the geodetic basis.

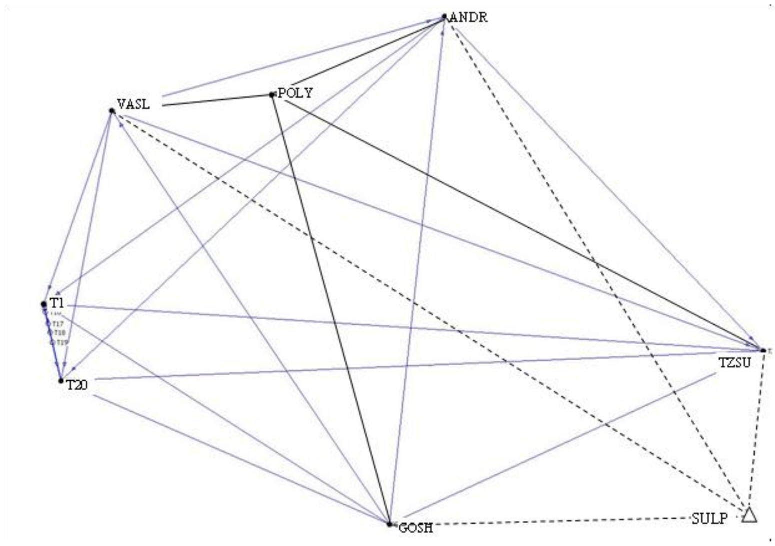

Fig. 1. Scheme of geodetic test network.

2. THE GEODETIC TEST NETWORK

The points of the geodetic test network were established in 2002. The network consists of 8 points (Fig. 1). Five of them are fixed by fundamental monoliths with the markers of a special design with a compulsory centering. The monoliths were set in a depth up to 4-4,5 m (Fig. 2).

For metrological control of the stability of points of the test network there are performed each year GPS campaigns duration of 3-4 days. Observations are performed by means of dual-frequency receivers Trimble. Analysis of results of determination of the point coordinates using long-term GPS observations indicate that the accuracy of determining coordinates is better than 1cm.

Fig. 2. The monolith for fixing the marker of geodetic points.

From the analysis of the long-term GPS observations there were determined the average values of coordinates of points referred to epoch 2005,47671 in system of coordinates ITRF2000 (Table 1). Also from the analysis of these coordinates of points

which were determined during 2005 - 2008, there were estimated the velocity of change of their coordinates (Table 2) (Trevoho I.S., et.al., 2009).

Table 1. RMS of coordinates points on epoch t_0=2005.4767

Point	m_X, mm	m_Y, mm	m_Z, mm
GOSH	2,0	2,5	1,7
ANDR	6,8	1,7	10,4
TZSU	3,0	0,6	3,4
VASL	2,9	3,4	6,3

Table 2. Velocities of a change of point coordinates and RMS

Point	Vx, mm/yr	m_{Vx}, mm/yr	Vy, mm/yr	m_{Vy}, mm/yr	Vz, mm/yr	m_{Vz}, mm/yr
SULP	-18,6	0,0	15,1	0,0	8,7	0,0
GOSH	-18,1	0,5	13,8	0,7	8,0	0,4
ANDR	-18,1	1,8	14,3	0,5	10,6	2,5
TZSU	-19,3	0,7	14,7	0,2	8,8	0,9
VASL	-19,8	0,5	15,5	0,9	9,7	1,8

3. THE GEODETIC TEST LINE BASIS

A linear geodetic basis was established in 2003. This was fixed by 20 special tubular markers with a compulsory centering. Length of geodetic basis is 2260 m. The length of the lines of geodetic basis was determined by GPS measurements, and by means of a precision geodetic instruments. Table 3 shows geodetic instruments by means of which there were made the metrological control certification of the lengths of lines for a geodetic basis during the years 2003 – 2009 (Trevoho I.S., et. al., 2010).

Table 3. Geodetic instruments used for the metrological control certification

Year of measurements	Instrument
2003	PLD-1M, ranger
2006	Trimble 5700, receiver GPS
2006	TS Trimble 5601 DR Standart
2007	TS Trimble 5601 DR Standart
2009	TS Leica TCR 1201+R400
2009	Trimble 5700, receiver GPS

In table 4 there are shown the results of determination of differences for the geodetic basis which were obtained by means of GPS measurements and their values measured by the precise laser rangefinder PLD-1M and also by means of the total stations in different years. Discrepancies between the values of the lines of the linear geodetic basis obtained by means GPS observations and using precise electronic total stations, generally not exceeded about 1mm. Thus, the results indicate that the differences between the values lines which were measured by total stations and obtained from GPS observations are of the same order.

Table 4. Results of the metrological control of the intervals of the linear geodetic basis

Inter-vals	Ranger PLD-1M 2003 p.	GPS Trimble 5700 2006 p.	TS Trimble 5601DR 2006 p.	TS Trimble 5601DR 2007 p.	TS Leica TCR1201 2009 p.	GPS Trimble 5700 2009 p.	Diff.2009 /max.diff
1-2	4,9820	4,9821	4,9816	4,9820	4,9824	4,9824	0,0/0,8
2-3	5,5464	5,5462	5,5469	5,5465	5,5456	5,5458	0,2/1,3
3-4	4,5031	4,5029	4,5031	4,5029	4,5029	4,5025	0,4/0,6
4-5	1,0052	1,0052	1,0046	1,0049	1,0054	1,0057	0,3/1,1
5-6	0,9984	0,9984	0,9982	0,9981	0,9983	0,9980	0,3/0,4
6-7	0,9939	0,9939	0,9943	0,9941	0,9943	0,9952	0,9/1,3
7-8	0,9960	0,9960	0,9954	0,9957	0,9958	0,9955	0,3/0,6
8-9	1,0028	1,0028	1,0036	1,0029	1,0035	1,0038	0,3/1,0
9-10	0,9956	0,9956	0,9955	0,9954	0,9945	0,9941	0,4/1,5
10-11	1,0000	1,0000	0,9993	1,0001	1,0002	1,0006	0,4/1,3
11-12	0,9984	0,9984	0,9994	0,9986	0,9993	0,9986	0,7/1,0
12-13	1,0009	1,0009	1,0002	1,0005	1,0004	1,0001	0,3/0,8
13-14	1,0085	1,0085	1,0083	1,0082	1,0071	1,0078	0,7/1,4
14-15	104,6327	104,6324	104,6318	104,6321	104,6318	104,6320	0,2/0,9
15-16	110,3288	110,3290	110,3291	110,3290	110,3310	110,3301	0,9/2,2
16-17	349,3760	349,3763			349,3746	349,3752	0,6/1,7
17-19	540,7750	540,7749			540,7759	540,7749	1,0/1,0
19-20	1129,7672	1129,7674			1129,7665	1129,7671	0,6/0,9

CONCLUSIONS

1. The long-term monitoring with use of the most up-to-date equipment has shown high spatial-temporary stability of objects for the points at a level of several millimeters for the fundamental geodetic network and < 1mm for the linear geodetic basis.

2. The experimental method of operative checking lines on the linear geodetic base with GPS-measurements provide accuracy up to 1mm.

3. The stability of the tubular centers of geodetic base as confirmed by long time control measurements, practically, have not changed a position.

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