National report of Belarus

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Introduction

The national report covers the activities of the Belarusian geodesy during the last years. The subject of this article is the experience of the determination of the single transformation parameters between reference coordinate systems ITRS and (SGRS95 RB) for the territory of the Republic of Belarus. The modernization of the State geodetic network of the Republic of Belarus in order to create the coordinate reference frame that allows using effectively actual methods of object coordinate determination for both applied and fundamental geodetic tasks. Creation of the network of permanent reference stations, precise leveling and gravity activities have a topical meaning.

1. Conception of realization SGRS95 RB

Since January, 01, 2010 National Reference Frame – State Geodetic Reference System of 1995 of the Republic of Belarus (SGRS95 RB) has been in use. Introduction of the National Reference Coordinate System on the territory of Belarus was caused by the necessity of preservation of the common coordinate space with Russian Federation in accordance with the political agreements and demands of the Ministry of Defense. Its specific features: preservation of the common coordinate space with Russian Federation and keeping to the portability to cartographic survey performed earlier as well as cadastral maintenance in the previous coordinate system and transitions of topographic and geodetic production to GNSS-methods.
Conceptual scheme of realization SGRS95 RB was developed by the State Unitary Enterprise of Aerial and Space Methods in Geodesy "Belaerocosmogeodesia" The scheme was carried out taking into account international standard ISO19111, INSPIRE directive and European countries experience and included: (1) creation of the Fiducial Astro-Geodetic Network and Precise Geodetic Network with fixed binding to reference points of IGS; (2) densification of the Precise Geodetic Network, creation of the 1st class Satellite Geodetic Network and determination of coordinates in ITRS; (3) determination of 7 Helmert parameters ITRS-SGRS95 (coordinates of the 1st and 2nd classes Astro-geodetic network, obtained by MAGP (Moscow Aerial Geodetic Enterprise, Russian Federation) with attraction of EGM 2008; (4) coordinate transformations of the Precise and the 1st class Satellite Geodetic Network points from ITRS to SGRS95 RB; (5) adjustment of the National Detail Geodetic Network (the compounded points of the 1st class Satellite Geodetic Network and Astro - geodetic network have to be fixed in SGRS95 RB).
While computation of transformation parameters we used EGM2008 geoid's model. We are convinced that this model is appropriate for the territory of the Republic of Belarus. The average quadratic deviation (RMS) of normal heights obtained with this model using geometric leveling is about 5 cm for the most part of the country. We have preserved the common coordinate space with Russian Federation and provided the possibility for Belarus to integrate into European coordinate space.

2. National Geodetic Network

The new structure of the National Geodetic Network consists of the:

- Fiducial Astro-Geodetic Network (FAGS in Minsk);
- Precise Geodetic Network (Zero order reference network);
- 1st class Satellite Geodetic Network (First order reference network);
- National Detail Geodetic Network.

Connection between the FAGS station and the coordinate system ITRS/ITRF2005 was exercised with fixed binding to 9 IGS stations (BOR1, JOZE, GLSV, MDVJ, METS, ONSA, POTS, POLV and WTZR). Some details of the campaign are:

- Observation time: 12x24 hours (April 2008);
- Processing software: Bernese software;
- Accuracy (RMS) of the coordinates: ± 0.8 mm, ± 0.3 mm, ± 2.0 mm in North, East and Up component.

Some details of the Precise Geodetic Network are:

- Number of points: 9;
- Observation time: 4x24 hours (April 2008);
- Processing software: Bernese software;
- Accuracy (RMS) of the coordinates: ± 1.0 mm, ± 0.7 mm, ± 3.0 mm in North, East and Up component.

Network solution includes 4 IGS stations (JOZE, GLSV, POTS and POLV) + FAGS station.

Some details of the 1st class Satellite Geodetic Network:

- Number of points: 846;
- Observation time: 2x6 hours (2001-2008yy);
- Processing software: Pinnacle, GeoLab;
- Accuracy (RMS) of the coordinates: ± 2.2 mm, ± 1.6 mm, ± 4.2 mm in North, East and Up component.

Network solution includes 9 points of the Precise Geodetic Network. 306 points (36%) were compounded with old triangulation points (1st and 2nd classes Astro-geodetic network). National Detail Geodetic Network includes 6 268 points. Figure 1 illustrates National Spatial Geodetic Network.

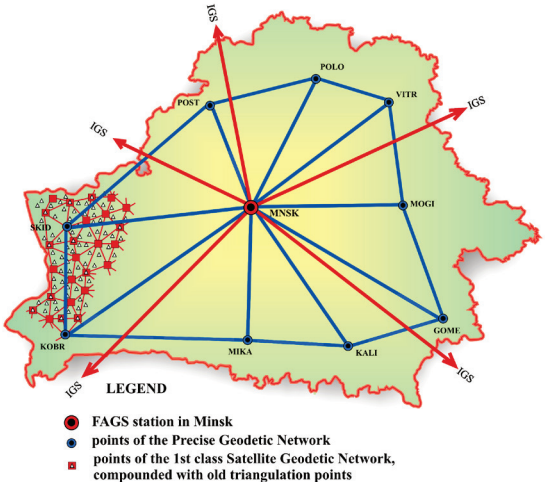

Fig. 1 Scheme of the National Spatial Geodetic Network

All coordinates were calculated for the epoch 23.04.2008 (1476.3).

3. The precise levelling and gravity activities

The system of normal heights on the territory of the Republic of Belarus is maintained by the networks of high-precision geometric levelling of the 1st and 2nd order classes. The Baltic 1977 height system is the official vertical system in the Republic of Belarus at present. From 1994 to 2004 the field campaign and preliminary adjustment of high accuracy levelling was carried out. It is included into common equalization of heights networks of Russia and Belarus. Nowadays TsNIIGAiK (Russia) prepares data for the transmission to Bundesamt für Kartographie und Geodäsie (BKG).

According to the agreements on cooperation between TsNIIGAiK (Russia), BKG (Germany) and FGI (Finland), the parties have been performing works on unification of base levelling nets. The main purpose of such unification is to create the unified height system for the whole territory of Europe.

Some details of the 1st class Belarusian levelling network:

- Approximately 3 700 km double run precise levelling;
- 1 930 bench marks;
- Levelling along railways and roads;
- Standard deviation after adjustment: 1.7 mm/√ km.

At present we are carrying out the works on reconstruction of the II order levelling lines.

Figure 2 illustrates levelling lines and absolute gravity points.

Fig. 2 Levelling lines and gravity points

The absolute gravimeter FG-5#110 TsNIIGAiK (Russia) has been used for determination of the absolute gravity acceleration at 4 sites in Belarus. Absolute gravity measurements were performed at Polotsk, Minsk, Gomel and Brest. Vertical gradients on absolute gravity points have been determined.

The analysis of repeatability between 50 drops has shown the rout mean square variations of about 6 microGals for the all stations. In the nearest future we will be involved in the project of the relative gravity measurements.

4. National Positioning Service

At present we are carrying out the works on the creation the network of permanent stations. Its development started with the realization of pilot-project on the territory of Minsk region. 15 stations were included in the project. Today there are 34 active stations in Belarus. The network of permanent reference stations will cover the entire territory of the Republic of Belarus by 2015 and will include 99 stations (Figure 3).

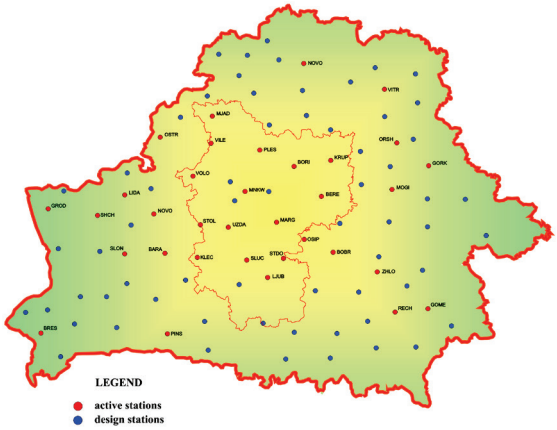

Fig. 3 National Positioning Service

All stations are located on the roofs of the buildings and spacing between them is about is 60-70 km. Post-processing service accuracy is 15 mm horizontal and 20 mm vertical. Network RTK service accuracy is 20 mm horizontal and 30 mm vertical, via mobile phones. Control soft: Leica Spider.

Coordinates have been calculated in ITRS with BERNESE software for the epoch 23.04.2008. We always include IGS reference points and FAGS station in common adjustment.

Thus, coordinates of all the points of satellite networks have been calculated in ITRF for one epoch and they are transformed to SGRS95 RB according to unified parameters. We do not have any losses in accuracy while transferring them from ITRF to National coordinate system and vice versa.

5. Future plans

1. Densification of the permanent stations;
2. Reconstruction of local geodetic networks. Determination of transformation models from SGRS95 RB to local coordinate systems in the administrative divisions;
3. Make next order of densification gravity network;
4. Modeling gravity-field and Quasigeoid computations with accuracy 2-3 cm data-based on EGM 2008;
5. Cooperation with the EPN and IGS.