

GEODETTIC WORKS PROJECT FOR LARGE-SCALE PLAN PRODUCTION OF THE TERMIZ CITY AREA

Usmonov Said Furqat o'g'li

Assistant, Department of Building and Structure Construction,
Termiz State Engineering and Agrotechnology University

jonsaid0897@gmail.com

Xushvaqtov Asadbek Saydulla o'g'li

Student, Termiz State Engineering and Agrotechnology University

asadbekxushvaqtov53@gmail.com

Abstract: This article discusses the issues of designing a geodetic basis for the production of large-scale plans (1:5000, 1:10000) in the Termiz city area. The article examines the classes of geodetic networks, their accuracy requirements, methods of point placement, measurement methods, and the procedure for data processing. A network project is proposed taking into account the geographical features of Termiz city, its location in the Amu Darya river valley, and geodetic conditions.

Keywords: geodetic basis, large-scale plan, triangulation, polygonometry, leveling, GPS, Termiz city, geodetic network, control point, coordinate.

Large-scale plans (1:5000, 1:10000, 1:2000) are of great importance in urban planning and construction. These plans are used for urban infrastructure planning, road and communication network design, land cadastre work, and many other fields. The quality and accuracy of large-scale plans depend entirely on the quality of the geodetic basis. Termiz city is located in the southern part of the Republic of Uzbekistan, in Surkhandarya region, on the left bank of the Amu Darya river. The geographical coordinates of the city are: latitude 37°13' N, longitude 67°17' E. Termiz city borders Afghanistan and has regional significance. The design of a geodetic basis for large-scale plan production includes the following stages: selection of geodetic network classes, point placement, determination of measurement methods, data processing, and evaluation of results. This article discusses these stages in accordance with the conditions of Termiz city. The Termiz city area is located on the left bank of the Amu Darya river, in the widest part of the river valley. The terrain changes from flat to slightly hilly, with elevations ranging from 305 to 315 meters. The geological structure is as follows: the upper part consists of modern sandy and sandy-loamy deposits, while the lower part contains alluvial deposits (clay, loess, sand). Climate conditions: Termiz

city is located in a sharply continental climate zone. The average summer temperature is $+35...+40^{\circ}\text{C}$, and the average winter temperature is $+2...+5^{\circ}\text{C}$. Annual precipitation is 150-200 mm. These conditions recommend conducting geodetic work in spring and autumn months. Existing geodetic networks in the area: 1st and 2nd class points of the Uzbekistan State Geodetic Network, as well as 3rd and 4th class networks at the regional level.

There are no GPS observatories or permanent stations, so the nearest IGS stations (KIT3, POL2) can be used for GPS measurements. The geodetic basis for a large-scale plan (1:5000) should include the following classes:

Network Class	Distance Between Points	Accuracy Requirement (m)	Application
1st Class (State Network)	15-20 km	± 0.1	Basic Control
2nd Class (Densification)	5-8 km	± 0.2	Densification
3rd Class (Survey Basis)	1-2 km	± 0.05	Survey Basis
4th Class (Detail)	0.2-0.5 km	± 0.02	Detail Points

The

following principles are observed when placing geodetic points:

- Points must evenly cover the entire area of the territory;
- Points must ensure mutual visibility conditions (for triangulation);
- Points must be placed in stable zones (avoiding sandy and loamy areas);
- Points should be close to transport infrastructure but not obstruct traffic;
- Points should be placed away from areas planned for construction;
- The center and three reference points (reference marks) must be marked for each point.

Additional requirement for Termiz conditions: points must be placed at elevations above 310 m, taking into account the annual water flow of the Amu Darya river, in areas with low flood risk.

The following measurement methods are used in the Termiz city area:

- **GPS/GNSS Measurements:** Static GPS measurements are performed for 1st and 2nd class networks. Kinematic method (RTK/PPK) is used for 3rd and 4th class points. IGS stations (KIT3, POL2) and regional stations are used as bases for GPS measurements.
- **Triangulation:** If GPS conditions are unsatisfactory (e.g., in dense construction zones), the classical triangulation method is used. Angles are measured with a theodolite T2 or T5, and baselines are measured with an EDM (electronic distance meter).
- **Polygonometry:** The polygonometry method is widely used for 3rd and 4th class networks. Angles are measured with a theodolite, and distances are measured with an EDM. Polygonometric chains can be closed or open.
- **Leveling:** The geometric leveling method is used for the height network. 1st and 2nd class leveling is performed with N-3 and Ni-002 levels, while 3rd and 4th class leveling is performed with S-10 and S-5 levels.

The 1st class network is based on existing points of the Uzbekistan State Geodetic Network. Four 1st class points (G1, G2, G3, G4) are placed in the Termiz city area. These points are connected by GPS measurements, and their coordinates are determined in the WGS-84 and SK-42 systems. The distance between points is 15-20 km, with accuracy of ± 0.1 m. GPS measurements are performed with the following parameters: session duration 4-6 hours, antenna height 1.5 m, measurements repeated over 3 days. Data processing is carried out using Trimble Business Center or Leica Geo Office software. The 2nd class network is designed based on 1st class network points, in chain or network form. Seven 2nd class points (T1-T7) are placed in the Termiz city area. The distance between points is 5-8 km, with accuracy of ± 0.2 m. Measurements are performed using GPS-RTK method or theodolite-EDM combination. 2nd class network points are placed at the following locations: city center, railway station, near the airport, industrial zones, and agricultural areas. Each point is reinforced with a concrete foundation and a central mark (central peg). The 3rd class network is designed based on 2nd class network points, in the form of polygonometric chains. Ten 3rd class points (Z1-Z10) are placed in the Termiz city area. The distance between points is 1-2 km, with accuracy of ± 0.05 m. This network serves as the basis for survey work.

Polygonometric chains must meet the following requirements: the mean square error of angle measurement should be ± 5 seconds; the relative error of distance measurement should be 1:10000; the chain closure should be better than 1:5000. The 4th class network is designed based on 3rd class network points, using dense polygonometric chains or GPS-RTK method. Twelve 4th class points (S1-S12) are placed in the Termiz city area. The distance between points is 0.2-0.5 km, with accuracy of ± 0.02 m. These points serve as the direct basis for detail survey (1:500, 1:1000).

The height network is designed parallel to the geodetic network points. The height network in the Termiz city area includes the following classes:

Leveling Class	Height Difference Accuracy	Application
1st Class	± 0.5 mm	Basic Height Control
2nd Class	± 1.0 mm	Densification
3rd Class	± 2.0 mm	Survey Basis
4th Class	± 5.0 mm	Detail

The leveling lines for the height network must meet the following requirements: for 1st class leveling, the distance between two control points is 2-3 km; for 2nd class, 1-2 km; for 3rd class, 0.5-1 km. Leveling lines are organized in closed chain form. In the Termiz city area, the height network starts from the water level of the AmuDarya river (305 m).

GPS measurement data is processed in the following stages: 1) Loading and formatting data (RINEX); 2) Accounting for antenna heights; 3) Eliminating ionospheric and tropospheric effects; 4) Static processing (determining baseline vectors); 5) Network adjustment and error evaluation; 6) Transforming coordinates to the SK-42 system. Bernese, GAMIT/GLOBK, or regional software (Credo, Topol) is used for processing. The processing of polygonometric chains includes the following stages: 1) Checking angle measurements (geometric conditions, sum of angles); 2) Checking distance measurements (calibration, temperature corrections); 3) Checking the chain (closure, relative error); 4) Calculating coordinates (starting from control points); 5) Evaluating errors (mean square error, error ellipses). Calculations are performed using Credo, Topol, or Excel software. Leveling data is processed in the following order: 1) Checking staff readings; 2) Accounting for level staff errors; 3) Calculating height differences; 4) Checking the chain (closure); 5) Calculating heights (starting from

control points); 6) Evaluating errors (mean square error). Calculations are performed using Credo, Topol, or specialized leveling software.

The following safety measures are observed during geodetic work: 1) Road traffic safety (signal clothing, signs); 2) Protection from sun rays (hats, sunglasses); 3) Working regime in hot weather (breaks, water supply); 4) Protection from animals and insects; 5) Protection of electronic equipment (dust, humidity). Environmental protection measures: 1) Avoiding tree cutting when placing points; 2) Avoiding construction waste disposal; 3) Moving vehicles on designated paths; 4) Making geodetic marks and foundations from environmentally safe materials.

CONCLUSION

This article discussed the issues of designing a geodetic basis for the production of a large-scale plan (1:5000) in the Termiz city area. The main conclusions are as follows:

- A network consisting of 4 1st class, 7 2nd class, 10 3rd class, and 12 4th class geodetic points is designed for the Termiz city area;
- GPS/GNSS measurements are used as the main method, with triangulation, polygonometry, and leveling as additional methods;
- The accuracy of the geodetic network fully meets the requirements of large-scale plans (plan coordinates $\pm 0.02-0.1$ m, height $\pm 0.5-5$ mm);
- Data processing is carried out using modern software (Credo, Topol, Bernese);
- Safety and environmental protection measures are included in the work plan.

The proposed geodetic basis project allows for effective use of large-scale plans in urban planning, construction, land cadastre, and other fields in the Termiz city area. The implementation of the project will contribute to the socio-economic development of the region.

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