Technological Aspects of Land Plots Surveying in Russia

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Key words:

ABSTRACT

As a result of land reform a new basis of land system has been created in Russia. Monopoly of state ownership on land has been abolished; a new class of land owners has been created, among them 45 mln. people. 130 mln. hectares of land were given to citizens and organizations as ownership.

Land Code of Russian Federation adopted on the 30th of December, 2001, put into effect conception of land not only as natural resources used as a means of production in agriculture and forestry, but at the same time as real property, an object of the right on ownership and right on land.

Every year on the territory of Russian Federation more than 0,5 mln. sale and purchase transactions of land plots between citizens have been implemented. Such transactions should be preceded by surveying of land plots, i.e., implementation of measures on definition of location and boundaries of land plots on the area.

Technological aspects of land plots surveying are given in the article which are subjects of sale and purchase between citizens of Russian Federation. Agreements between land plots owners and executors of work or judicial decisions can serve as background in such a case. Juridical persons or individual enterpreneurs having a licence on land use planning work fulfillment are executors of land plot surveying.

Land plot surveying should include the following main steps:

- To determine and co-ordinate land plots boundaries on the locality
- To fix boundaries location on the area by surveying signs and determine their flat rectangular coordinates
- To calculate land plot area
- To make a plan of land plot boundaries.

Russian Federation Committee on land resources and land use planning (Roskomzem) "Instruction on lands surveying" adopted in 1996 is the main normative – legal document of land plots surveying on the territory of Russia.

Technological aspects of land plots surveying in accordance with the stages of work adopted in Russian Federation are shortly stated below.

Determination of land plot boundaries on the locality and their agreement are made in land owners, proprietors and users of concerned land plots or authorized persons presence whose rights are legally certified. If some debates about land plots location and their boundaries on the area are appeared during agreement then land plot surveying is stopped up to its decision, including in legal form. Land plot boundaries determination and agreement results on the locality are registered officially by an act which must be signed by all participants of this procedure including an executor of work. The act is approved by the Committee on land resources and land use planning of the district (city) of the subject of Russian Federation.

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procedure including an executor of work. The act is approved by the Committee on land resources and land use planning of the district (city) of the subject of Russian Federation.

Surveying signs fixing on the locality and their flat rectangular coordinates determination are made after previous procedure which was devoted to definition and agreement of land plot boundaries. Surveying signs are placed on turning points of a land plot boundary. If boundaries coincide with natural and artificial bars (rivers, streamlets, canals, fences, blocks of houses, etc.) it's not necessary to fix surveying signs.

Marks on separate constructional elements of buildings and facilities which must be described by all means serve as boundary points on built territory. Different types of surveying signs are used to fix boundaries each depending on local conditions, the end of which is fixed by flat rectangular coordinates. If there are not any buildings on the area wooden poles, metal pipes, etc. are used as surveying signs, and if there are some buildings special marks, nails and other metal articles are used which are fixed by cement solution on the foundations of different facilities, including asphalt covering, kerbs, etc.

As geodetic basis of land surveying can serve centres of:

- State geodetic network (SGN).
- Strong point of surveying network (SPSN).

SPSN centres are initial phases for single coordinate basis establishing on administrative regions areas for carrying out state land cadastre, land use planning, including land plots surveying, monitoring and land inventory for different purposes. They are also used for quick renewal of lost surveying signs and other state land cadastre and land use planning problems decision.

At state geodetic network points and strong points of surveying network are usually located a great way off from a land plot to determine surveying signs coordinates it's necessary to create surveying network (SN). Centres of SN can be combined with surveying signs or should be located near here.

Strong point of surveying network and land plots surveying building accuracy for some land categories are given in table # 1.

Characteristics of land plots surveying accuracy.

N	Land categories	Mean quadrature errors (standards), cm		
		Mutual positions' adjacent points SPSN	SN points position in relation to the nearest centres of SGN and SPSN	Surveying signs position in relation to the nearest SN point
1	2	3	4	5
1	Lands for urban settlements	3 – 5	5 – 10	3
2	Land for rural settlements	5 – 10	10 –20	5
3	Lands for agricultural purposes	10	20 – 50	10

Range of mean quadrature errors changes shown in this table, e.g., are explained by urban and rural buildings density, by presence of multistory capital buildings, by density of engineering communications, by high values of agricultural lands, etc.

Strong point of surveying network technology creation includes the following stages of work:

- Planning, reconnoitre and technical projecting
- Points centres laying
- Geodetic measurements
- Field calculations and quality measurements control
- Making SPSN coordinates catalogue.

Technical projecting provides the most reliable and economic methods using for strong point of surveying network creation based upon suitable calculations which must meet land plot surveying accuracy needs (table 1, colomn 3). Coordinates of SPSN centres are mainly determined in according to the observations of GLONASS and NAVSTAR systems Earth artificial satellites in "statica" regime. A story point of surveying network is fixed to not less than 2 state geodetic centres of SGN/or SPSN of previous development stage. SPSN are fixed to the location by the centres providing their long-term safety and stability both in a plan and on the height. A mark with a sign is a constitutive element of SPSN centres to which flat rectangular coordinates and height are concerned. An appropriate signature is made on the mark and SPSN centres number is indicated. SPSN centres are located, as a rule, on lands which are state or municipal ownership taking into consideration their access to fix equipment to work with them. After laying SPSN centres are passed by an act to provide their safety.

When creating SPSN flat rectangular coordinates are used in Gauss projection which are determined in local coordinates systems. Simple connection between local coordinates systems and adopted state coordinates system is provided. For each local coordinates system the following parametres of coordinate network on the plane in Gauss projection is established:

- Longitude of axis meridian
- Number of coordinate zones
- Coordinates of conditional starting.

Mathematical interpretation of geodetic measurements is carried out using suitable software. Mean quadrature errors value of SPSN network elements calculated in accordance with equation results must correspond to data presented in table 1.

SPSN centres coordinates catalogues are made when geodetic works and their mathematical interpretation are finished. Catalogues keeping, as a rule, is carried out in electronic form.

SPSN centres flat rectangular coordinates are indicated in a catalogue as well as their height in the Baltic system, which are determined in according to mathematical interpretation of satellite geodetic measurements.

SPSN centres and state geodetic network serve as initial geodetic basis for surveying network building and determination of flat rectangular coordinates of surveying signs.

As it was mentioned above SN can be combined with surveying signs or they must be located close to them. In such a case a polar method is usually applied to determine surveying signs coordinates, using electronic tacheometer to define surveying signs polar coordinates. SN centres serve as initial geodetic points in such a case. To determine flat rectangular coordinates of surveying network points the following methods are used:

- Satellite geodetic determination
- Polygonometry (usually on settling lands)
- Geodetic straight and combined marks, etc.

When it is grounded photogrammetric methods are used if technical requirements mentioned in the above table data are carried out. Selection methods of surveying network making are dictated by local conditions, relevant equipment, economical and other factors. When geodetic work is conducted it is possible to determine height of surveying signs taking into account special requirements.

Mathematical interpretation of geodetic measurements is conducted on the basis of software, which makes it possible to get data about land plot location quickly with accuracy from 3 – 5 cm up to 30 – 50 cm depending on land categories, density and building number of storeys, agricultural lands value and so on (see table 1).

Land plot area is calculated in accordance with surveying signs. Well-known formulae are used for it.

$$P = \frac{1}{2}\sum_{i=1}^{n} x_i \left(y_{i+1} - y_{i-1}\right) = \frac{1}{2}\sum_{i=1}^{n} y_i \left(x_{i+1} - x_{i-1}\right),$$

where:

P – is a calculated area of a land plot;

x_i and y_i — are abscissa and ordinate of surveying sign "i";

i – is a number of surveying sign (i = 1, 2, 3 ….n).

As it was mentioned above land plots owners who have legal documents on right of ownership can serve as subjects of surveying. Their area (P_0) must be indicated. Therefore the next step of land plots surveying is P and P_0 areas comparison and assessment of their significance and divergence. Divergence modulus |ΔP| is calculated for this purpose which is equal to

$$|\Delta P| = |P - P_0|,$$

Revealed divergence can be received for different reasons, including at the expense of unauthorized changes of land plots boundaries, geodetic measurements errors when surveying a land plot, etc. Admissible divergence $\overline{|\Delta P|}$ is calculated in accordance with the following formula:

$$\overline{|\Delta P|} = 3{,}5\sigma_t \sqrt{P_0},$$

where:

σ_t – is mean quadrature deviation (standard) of a surveying sign position, which is expressed in metres.

Standard σ_t value is equal to

$$\sigma_t = \left(\sigma_{t_1}^2 + \sigma_{t_2}^2\right)^{1/2},$$

where:

σ_{t_1} – is surveying network centres position standard;

σ_{t_2} – is surveying signs position standard in relation to SN centre.

When a surveying sign is combined with SN centre σ_{t_2} is equal to 0.

σ_{t_1} and σ_{t_2} standards values are given in colomns 4 and 5 of table 1 accordingly.

Comparing divergence |ΔP| with its admissible value $\overline{|\Delta P|}$ the following decisions can be taken. If |ΔP| > $\overline{|\Delta P|}$, then surveying results are sent to a district (city) administration to make appropriate corrections in the document fixing area of a land plot P_0. When |ΔP| ≤ $\overline{|\Delta P|}$

area of a land plot is equal to P0 value, indicated in the document on land plot ownership right. In the last case a land plot, which is occupied by a buyer (a landowner), in fact, is a subject of sale and purchase.

A plan of land plot boundaries is one of the main surveying document. Established information about a land plot, surveying signs and their numbers, geodetic data (directional angles and lines length) and others which are necessary to form a surveying file are shown in a plan. This file is used to conduct state cadastre tittle of a land plot.

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