

METHOD IMPROVEMENT OF GEODYNAMIC SURVEY LOOP POINTS OFFSET TO THE AREA

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Abstract. The article provides information on the current situation concerning the method of geodetic provision of bringing to the area the points or range elements. It is recommended for bringing in real (to the area) the points of geodynamic survey loop to use GPS-receiver Topcon Hiper, as well as the controller to use a laptop with preinstalled software TopSURV, which is connected to the receiver in the field conditions. Existing methods of transferring the project to the area were analyzed, and it was indicated that the considered problem is one of the most important and responsible part of geodetic engineers. So, all stages of geodetic works require very serious approach to them, starting with their preparation and finishing with the performance on the construction site. Opinion according the need to improve existing techniques and technologies of geodetic drafting in respect to the bringing points to the area is reasoned. Technological and methodological features of the works on bringing points with known coordinates, set direction, lists of points are described in details. The method of pointing geodetic survey for bringing the points of geodynamic loop on the area in complex conditions of construction site using GPS-receiver allows you to choose the most efficient and modern way to solve issues and problems of bringing points of the project to the area and to learn new practical skills was proposed and tested in the field conditions.

Keywords. Geodynamic survey loop, geodetic provision, GPS.

Introduction. Geodynamic parameters of the rock mass crucially determine the mechanical strength and environmental safety of any engineering structures [1]. Geodynamic zones which separate blocks of different rock mass of tectonic activity, are everywhere and are a threat to all man-made objects. They are characterized by increased fracturing, extensive development of breccias and high permeability any liquid and especially natural and man-made surface water. Typically, these zones are places of development of temporary and permanent (river) water courses and humble forms of relief, suitable for the construction of various ponds, storage ponds and slime storage and tailings.

In addition, these areas are potential sites of active processes and phenomena development associated with the geological activity of surface and groundwater, which can cause flooding and water logging of areas, the destruction of dams and other engineering structures, etc., that is a prerequisite for emergencies of natural and man-made disasters [2]. In this regard, monitoring of such geodynamic zones features changes is the key to safe operation of hydro-engineering facilities, which include tailings.

The construction of the tailings of Kryvyi Rih mining and processing plant of oxidized ores (KMPPPO) has disrupted the natural hydrodynamic regime of surface and groundwater, creating of

man-made landforms that affected the redistribution of overburden pressure within massives of rocks [3]. These changes of the natural properties of the geological environment led to the activation of erosion that affected the increasing dynamics of the ravine-beam system of Krynychuvatska gulch and activated natural tectonic movements that affected the stability of the dam main body of the tailings as man-made landforms.

Modern tectonic movements and related with them processes of bulge forming belong to natural phenomena that can not be stopped. But today in the area of tailings natural and anthropogenic system was formed, further development of which is directly dependent on the human activity. At measures developing to prevent emergencies, necessary condition should be taken into account all the factors together. Only a comprehensive minimize of their impact on the natural and man-made system can achieve positive results [4-6].

The issue of methods choice for constructing horizontal and vertical geodetic networks, the estimation of measurement accuracy, the use of appropriate advanced technology and equipment, processing and analysis of observations of calculation and prediction of deformations of the earth's crust, surface mobility structures is paramount when monitoring geodynamic ground of construction area of KMPPPO. One of the most

important issues is to create the completion survey network for reliable determination of horizontal and vertical movements of the earth's surface [7, 8].

Transfer the project to the area is one of the most important and responsible part of geodetic engineers activity. So, all stages of geodetic works, starting from their preparation and finishing with the performance on the construction site, require a serious attitude toward them, the ability to choose the most rational ways to solve them. Improvement of existing methods and technologies of project geodetic training as for to bringing to the area the points or range elements of buildings will acquire practical skills in solving these issues [9].

Materials and methods. KMPPPO tailings is located in central part of Ingulets megablock of Ukrainian shield, in the structure of which involved metamorphosed volcano-sedimentary and granitoid formation of Paleoproterozoic which are overlapped with Cenozoic sediments of sedimentary cover (Fig. 1).

In structural terms the area of the study area is located within the block bounded by regional faults of mantle cow laying of submeridional stretch: from the west - Kirovograd discharges, from the East - West Inguletskiy discharge. The block located between them is broken by northwest faults (Dolynska and Bokov'yanska fault zone), northeastern and sublatitudinal (Bobrynets fault) stretch into a number of blocks of higher orders. Against the background of these three areas with Isayivska tectonic zone north-eastern stretch is segregated in contrast that separates Dolynska anticline and Krynychuvatsky dome.

In terms of geomorphology, this area is controlled by Krynychuvatskoyu gulch, the top of which is the object of research - the KMPPPO tailings dam oriented across the strike zone (Fig. 2).

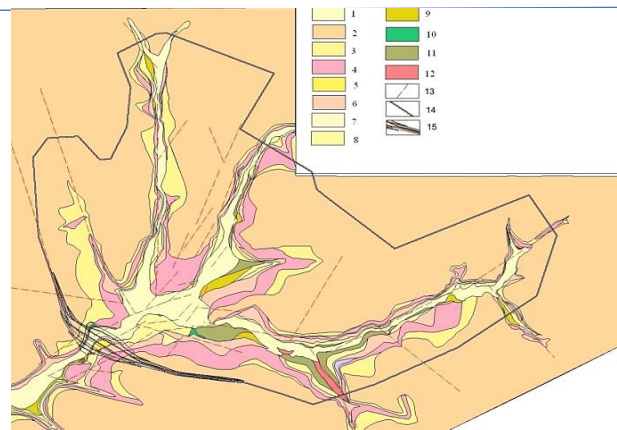


Figure 1. Geological map of tailings area: 1-3 – upper quaternary deposits: 1 – black loam, brownish-black tight ductile with lenses and layers of fine-grained sand; 2 – brown-yellow loess loam; 3 – pale yellow loess loam; 4-5 – middle quaternary deposits: 4 – yellow-brown loess loams; 5 – light brown to gray loam loess; 6 – lower quaternary reddish-brown loam; 7 – indivisible lower and upper Neogene Quaternary red-brown loam with lenses of red-brown loam; 8 – Lower Neogene sandy gray clay with inclusions of breakstone; 9-10 – dispersed zone of weathering crust: 9 - subzone of clay weathering products; 10 – subzone of sand and clay weathering products; 11 – breakstone zone of weathering crust represented with fragments of granite and migmatites; 12 – Precambrian crystalline basement granites; 13 – faults in the Precambrian crystalline basement that fade because of neotectonic movements occur in rocks of sedimentary cover; 14 –tailings outline; 15 – main dam of tailings.

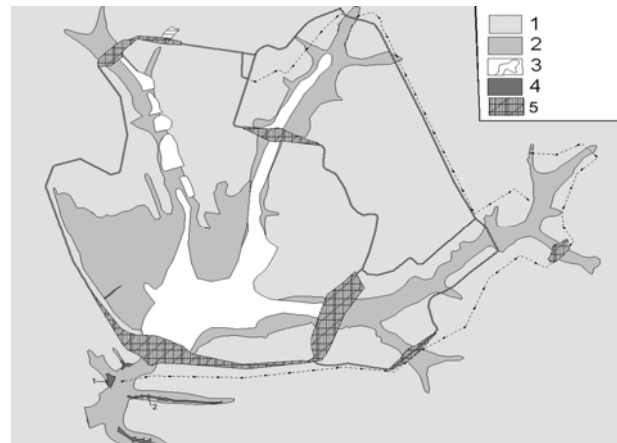


Figure 2. Geomorphological map of tailings area: 1 – relief created by alternating processes of denudation-accumulative alignment; 2 – erosional relief reworked by power processes of erosion and denudation (erosional denudation-slopes of river valleys); 3 – floodplain, formed by erosion and denudation processes of Holocene time; 4 – erosion and accumulative relief created by modern anthropogenic and natural phenomena; 5 – the technogenic relief (dam); 6 – tailings outline.

Special attention is paid to changing of valley line gulch morphology. Throughout its scope wells development so called gullies is observed (Fig.



3). These microforms are isometric in plan, the radius of 1.5-2 to 6 m and depth of 1- 2 m. Their formation is of multistage character.



Figure 3. Gullies in valley line of gulch

In the first stage across valley line of loess loam permeable zones are formed, the reason may be due to activation of fault tectonics because of neotectonic movements. In the second stage, within these highly permeable to atmospheric water areas, there is a depth of infiltration of loess loam flooding and their subsidence with formation in longitudinal profile of the outstanding differences valley line. The third stage is characterized by the formation on the gulch bottom of temporal flow, which causes activation of the summit of difference, and the fourth stage - water flow leading to turbulent erosion of rocks below the summit of difference on the principle of formation evrosion potholes. However, a prerequisite for inclusion of such a mechanism should be lowering the base level of erosion of gulch that is likely to be the prerogative of neotectonic movements within the area of rocks of tailings. In favor of this version serves development along the near valley line of the slopes of the cracks gulch with the formation of minute movement (Fig. 4) as geomorphological characteristics of neotectonic phenomena existence.

Based on comparative analysis of existing and possible methods of planning geodetic networks design [10-13] it was concluded that the most appropriate method of routine monitoring is not classical triangulation methods, which have

insufficient precision, and modern methods, including: monitoring with GPS-receivers and linear-angular network by the new total stations. Review of methods for determining heights showed that the highest accuracy, which requires monitoring of geodynamic polygon can provide precise geometric leveling. Definition of heights by GPS has an advantage over geometric leveling in solving regional and global problems of geodynamics, when points mobility is investigated that are separated in space for hundreds and thousands of miles. The accuracy of heights definition with GPS is somewhat worse than this definition by planning regulations and is in vertical error vectors $m_{\Delta H} \geq 3mm$.



Figure 4. Cracks of separation in valley line slopes of gulch

In order to study the nature of modern manifestation of vertical movements of the earth's surface in time and space it is recommended to restore regional geodynamic loop of KMPPOO. To perform geodetic observations altitude network design based on a detailed study of geological and tectonic and geomorphic condition of studied region is developed and proved. The project provides laying of leveling lines of 1st grade by brief beam (no more than 25 m).

The complex tectonic situation of the magnetic concentration tailings construction

identified the need to consolidate its area frame system that formed 4 closed survey loops to perform repeated and long-term (5-6 years) observations, which perimeters are respectively equal to: $L_1 = 3.53$ km; $L_2 = 3.11$ km; $L_3 = 15.75$ km; $L_4 = 4.35$ km. The project provides for the restoration of two deformation fields (DF), interconnected with each other by ground reference points. Under the tab 2 plots were selected, according to preliminary estimates were characterized by different intensities of geodynamic processes and placed near a fault as sublatitudinal and submeridional course (Fig. 5)



Figure 5. Scheme of geodynamic site on Google satellite image

Choice of method of bringing project points to the area depends on character of development, length of the survey loop, defined accuracy and availability of geodetic network points or support geodetic study. If there are many clear contours nearby points then it is convenient to use graphical method of determining the alignment elements. In this case, as data for bringing points to the area angles and distances are used, which are obtained from topographic plan used for designing. Accuracy of bringing in this case depends on the scale of the plan, the accuracy of the application of projected points on the plan, the definition from plan of

unknown elements, deformation of the plan. The analytical method is used in such cases when little geodetic points were preserved on the area and design points are away from them for long distances. To determine the location for the planned position of the points to be considered, using such methods [14]: 1) polar; 2) direct angular serif; 3) linear serif; 4) alignment serif; 5) perpendicular. The specialists used traditional surveying instruments.

Recent advances in geodetic instrument can improve productivity through the use of GPS-receivers when creating or restoring area points of geodynamic loop is very undeveloped, no contour

objects that could serve as a reference on the ground.

Results. For bringing points in the area it is recommended to use Topcon Hiper [15]. As the controller laptop with preinstalled TopSURV software is used, that is connected to the receiver in the field conditions. The method of carrying out works is described below.

Choose menu **Stake> Points** and in box **Stakeout Point** click **Settings** (Fig. 6). For GPS-receiver: in the box **Stakeout Parameters** set parameters of taking into real, namely tolerance deviation in the plan and the initial direction. We note a way to create titles and notes to the points and choose the type of baseline decision. To restore the proposed values, press the button **Defaults**. If you want to point the icon that is brought to the area (in nature), was shown on the map, the menu in the upper left corner of the **Stakeout Parameters**, choose position **Display**.

Choose a design point of survey loop from a list or map, or enter its name manually, and ask for the GPS receiver antenna parameters (height, type and method of measurement). If takeaway of PTL points is implemented, denote the appropriate field. In the **Stakeout Point** box press button **Stakeout** (Fig. 7)

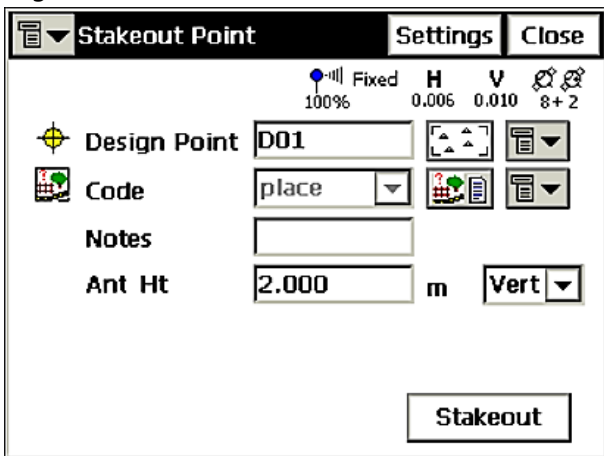


Figure 6. Bringing the points in the area

For GPS receiver when looking for design point you should be guided by the information supplied in the box **Stakeout**. After matching close enough to it, click **Store**. To move to the next (the list of data) of design point, press the **Next Pt**.

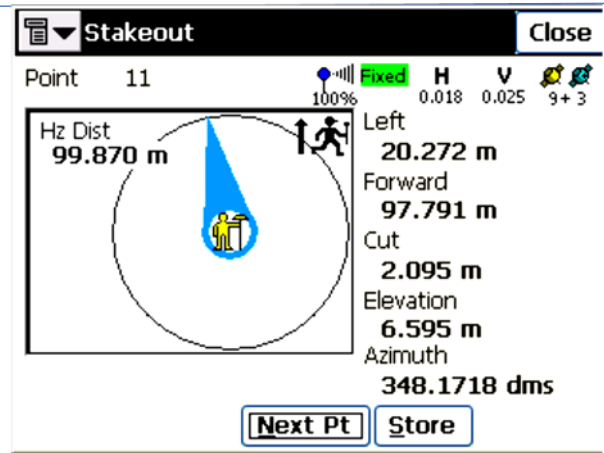


Figure 7. Work window of defined parameters for the bringing of points in the area

If the point coordinates are not known, but asked the direction and distance to it from the original (reference) point **Stakeout Point in Direction** function is used.

To take-out points in a given direction, select **Stake> Point in Direction**. In the box **Stakeout Point in Direction** enter the name of the starting point (reference), the azimuth of the point that is taken out, directly or as specified angle is measured from the direction at some other point (output), the angular deviation from the original azimuth, offset by a distance along the angular displacement at point deviation in height and antenna parameters (GPS mode). In the box **Store Pt** enter the name of the point, which is proposed, confirm by pressing **Stakeout** (Fig. 8).

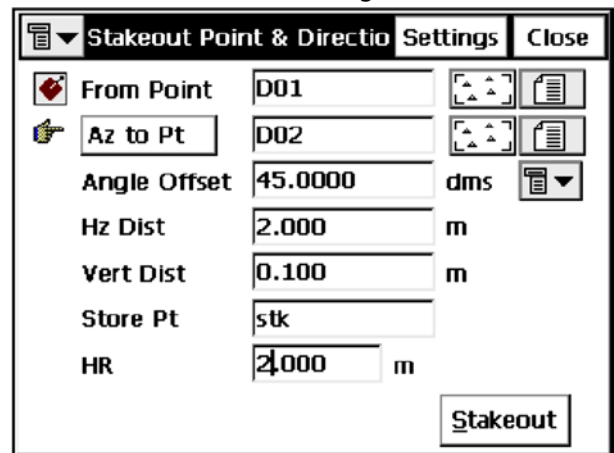


Figure 8. Bringing points in the direction

For bringing to the area points that make up the list, select **Stake> Point List**. In the **Stakeout Point List** box select pre-set list of points, set the antenna parameters when working with GPS receiver (antenna height reference point (ARP)).

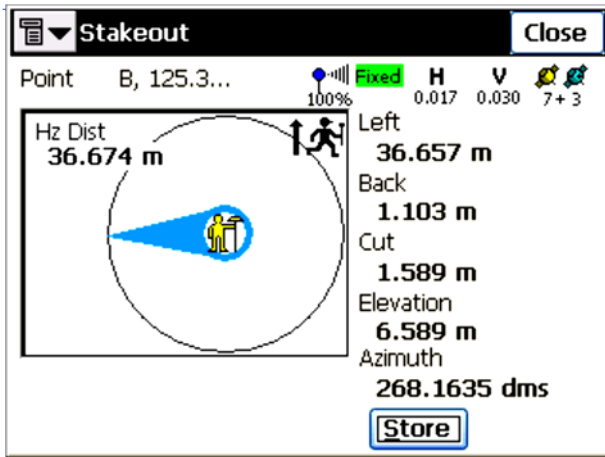


Figure 9. Work window preserving the direction issued on terms

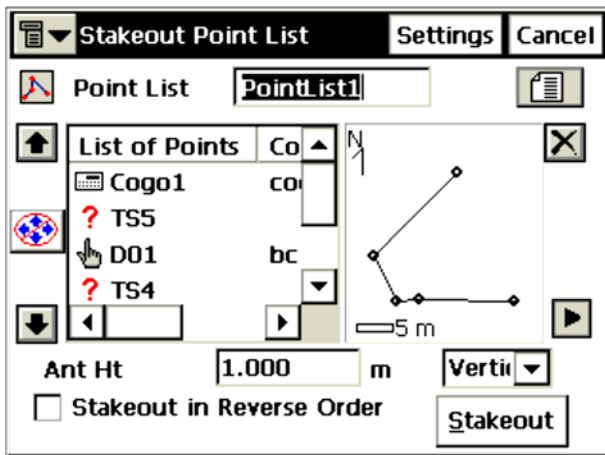


Figure 10. Bringing marks according the list of points

When using GPS receiver to find the point that is to be taken to the area information that is provided in the box **Stakeout**. When approach close enough to the desired position, press **Store** (Fig. 9). If you want to start taking points to the area from the end of the list, note the box **Stakeout in Reverse Order**. To change the order of taking points out randomly, use the arrow keys. Then click **Stakeout**, it is shown in Fig. 10.

Conclusions. The carried out analysis showed that the traditional method of making geodetic network points of the project cannot meet the full amount of user requirements on execution speed of this kind of survey works. Proposed and tested in the field conditions method of marking geodetic survey of taking points to the area in complex conditions of a construction site using a GPS receiver let select the most efficient and

modern way to solve issues and problems of bringing points of the project to the area and to learn new practical skills.

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