APPLICATION OF MODERN TECHNOLOGIES IN GEODETIC LEVELING WORKS. COMPUTER-AIDED DESIGN SYSTEMS IN GEODETIC ALIGNMENT WORKS

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Abstract. The construction site alignment network is selected depending on the presence of signs on the ground, its possible thickening, use for securing axes and other characteristics. The alignment network is connected with the designed buildings and structures by graphical constructions. All necessary dimensions of this connection are indicated on a special layout drawing.

The development of a general plan is carried out in AutoCAD software or other graphic programs that practically combine the well-known principles of determining the location of an object on the ground.

Keywords: breakdown network. coordinate system. construction site. geodetic basis. design. network engineering.

The layout drawing of a building, structure or land plot is drawn up on the basis of data from the general or topographic plan. General plans for construction projects are currently in electronic form, mainly in dxf, dwg or pdf format. The geodetic basis for developing a general plan is the geodetic support network. The choice of method for constructing a geodetic basis depends on the size of the territory and terrain features, the type of construction and the required accuracy of constructing the network. The system of coordinates and heights of the general plan is established by the topographic plan. Therefore, all constructions and calculations on the general plan are carried out taking into account the adopted coordinate system and heights of the topographic plan. The construction site alignment network is selected depending on the presence of signs on the ground, its possible thickening, use for securing axes and other characteristics. The alignment network is connected with the designed buildings and structures by graphical constructions. All necessary dimensions of this connection are indicated on a special layout drawing.

The development of a general plan is carried out in AutoCAD software or other graphic programs that practically combine the well-known principles of determining the location of an object on the ground.

The results of geodetic preparation are displayed on layout drawings. Alignment drawing is a graphic document made on a scale of 1:200 – 1:2000, according to which alignment work is carried out on the ground (Figure 1).
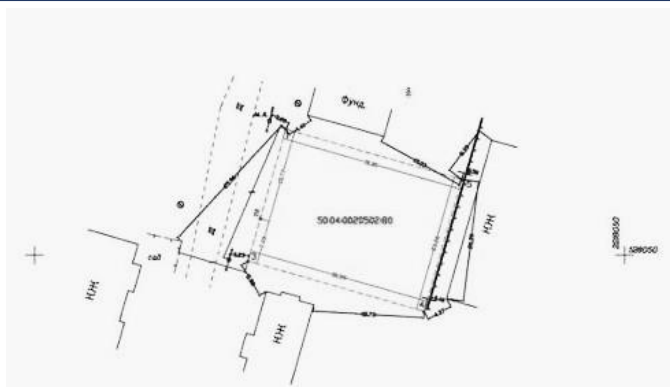
Figure 1 – Layout drawing of the land plot

The alignment drawing must reflect the starting points, the contours of buildings and structures, alignment elements, the points of which must be placed on the ground, their dimensions and the location of the axes. The drawing may indicate additional data that allows you to perform control measurements in case of any discrepancies.

The main CAD (Computer Aided Design) modules used to solve problems of office processing of geodetic measurements and design are AutoCAD and Autodesk Civil 3D.

Autodesk Civil 3D

For the design and execution of master plans in the Autodesk AutoCAD Civil 3D environment there is a specialized intelligent tool that allow you to create complex architectural forms on large and small objects. Objects are formed based on specified slopes, fixed or floating elevations, as well as by specifying slopes, retaining walls, pedestrian paths and roads. A system of dynamic marks that automatically change the displayed values of heights, coordinates, slopes, lengths, elevations, allows you to make the necessary decisions and save time on preparing output documentation. In combination with Autodesk AutoCAD blocks, it is possible to obtain different views of the same designed model without its restructuring or additional design. The adaptation package for GOST in combination with dynamic tags allows you to design output products at the design stage in strict accordance with the rules for preparing design documentation. The additional module "Earthwork Cartogram" allows you to generate a calculation of the balance of earth masses in strict accordance with the requirements.

Road design. AutoCAD Civil 3D has extensive functionality for highway design. There is a full set of tools for tracing the road, creating complex transitional, floating and free curves, and connecting complex sections. An existing profile is automatically built along the created route, with all the necessary labels and explanations according to GOST. The plan and the route profile are interconnected - any changes in the plan automatically lead to a change in the route profile. To create a design profile, there is a complete set of tools that allow you to create complex vertical route elements. The program includes an extensive library of roadway designs. Designs can be edited by the designer, it is also possible to create your own designs and make them also part of the library, which allows you to use custom designs in many projects. The program also automatically creates cross sections along the route. The route in the program is represented as a special complex dynamic object - a corridor, in which a change in any element leads to an automatic change in all other elements interconnected with it. It is correct to make design changes at any stage of road design. Tools for visual analysis of the dynamic corridor model have been implemented: analysis of visibility along the corridor, construction of visibility zones at a certain point in the corridor.

Design of external engineering networks and pipelines (Figure 2). The program allows you to design water supply and sewerage networks, as well as pipelines for any purpose. The product includes an "Element Builder", which allows you to create pipes and wells of any shape and purpose. The product comes with a library of ready-made network elements that can be edited. Autodesk AutoCAD Civil 3D automatically generates a network profile as well as the necessary specifications for the network. The functionality of the product provides the ability to set criteria based on which the product will automatically detect and, if necessary, correct collisions in networks.
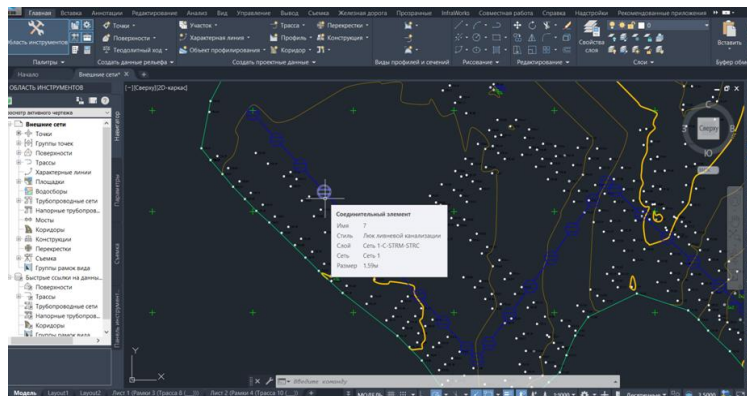

Figure 2 - Designing a pipeline network in AutoCAD Civil 3D

Autodesk AutoCAD Civil 3D also has the ability to design pressure engineering networks based on updated catalogs of pipes and equipment. All elements used in the design can be included in dynamic tables and specifications.

The basic Autodesk Civil 3D module has a special utility that allows you to transfer data into the program directly from Trimble instruments.

3D surface visualization and analysis capabilities enable you to perform spatial design work in Autodesk Civil 3D. The program is optimal for solving problems related to the cadaster, since it provides everything necessary for working with land plots.

Autodesk Civil 3D includes Autodesk Map 3D software, which provides the ability to create and mark geodetic points, define and edit land plots and road curves, automate the preparation of drawings, create digital terrain models, calculate contour lines, and volumes of excavation work.

The main task of the program is to prepare information for subsequent design.

Applications for Autodesk Civil 3D include:

- solving engineering and geodetic problems (using the additional Autodesk Survey module);

- construction of digital terrain models;

- construction of digital three-dimensional surface models;

- calculation of excavation/fill volumes with graphical and tabular display of results;

- design of municipal and other master plans;

- design of master plans for industrial facilities;

- design of linear objects;

- site design.

The result of Autodesk Civil 3D work can be design documentation, drawings, calculations, specifications.

Using an example, we will consider the development of a land plot alignment drawing using the AutoCAD Civil 3D program.

As initial information on an object, a digital topographic plan can be presented, consisting of a set of AutoCAD primitives (segments, arcs, points, text), as well as the coordinates of four reference points determined using GPS measurements. Based on the topographic plan data, geopoints are created in a semi-automatic mode (Figure 3).
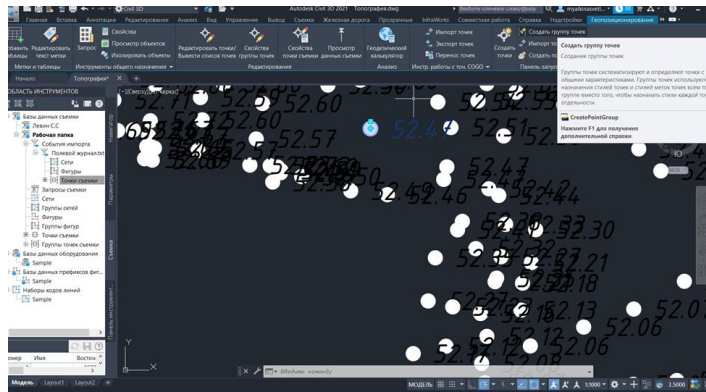

Figure 3 – Creating geopoints

Using the program's tools, a surface is built using a group of geopoints and existing primitives related to the terrain, which is subsequently converted into the LandXML format.

To compile a survey database and link the projected area to reference points, the inverse geodetic problem is solved as a method: geopoints are encoded and divided into groups (by area, taking into account visibility), and the location points of the device (Trimble M3 DR 5 electronic total station) are selected from the original topographic plan "). Then the corresponding groups of geopoints from these stations are transferred to the device format, and it, in turn, must be converted to the Autodesk.FBK format using the Survey Link Extension application. The Survey module and its Survey Link Extension are included in the AutoCAD program Civil 3D and are designed to communicate with geodetic instruments and work with raw data files.

The Autodesk.FBK file is loaded into a new Survey module project and its adjustment is carried out using the least squares method (LS). At the same time, objects - figures, the style of which corresponded to linear topographical signs (fences, water pipes, slopes, boundaries, etc.) are inserted into the digital plan by encoding points. Point topographical symbols are also displayed on the plan, in accordance with the styles of the point code descriptor key set.

Processing of field measurement results ends with the creation of a surface with figures and survey points. The shapes are treated as break lines on the surface while maintaining a dynamic relationship with the Autodesk.FBK file and the Survey module project. A surface is a dynamic object, like all AutoCAD Civil 3D objects, so when you edit the source data, the surface and other elements associated with it are updated almost instantly. Surface styles and tools allow you to conduct a detailed analysis and correct possible errors made during topographic surveying, and correctly build a triangulation network.

Dividing the territory into sections. The territory of the object given in the example is divided into separate plots for individual housing construction and one plot for general use. A topographic plan and surface created in AutoCAD Civil 3D is used to determine the location of each site. After the design is completed, the boundaries of the sections are updated using the digital elevation model, and the coordinates of the turning points of each section are determined in accordance with their boundaries. During the final preparation of the alignment drawing, the

boundaries of the plots are drawn up in appropriate styles with captions of the plot numbers and their areas. To carry out and break down the project into nature, the coordinates of the turning points of the boundaries of the designed sections are signed using callouts on the alignment drawing (Figure 4).
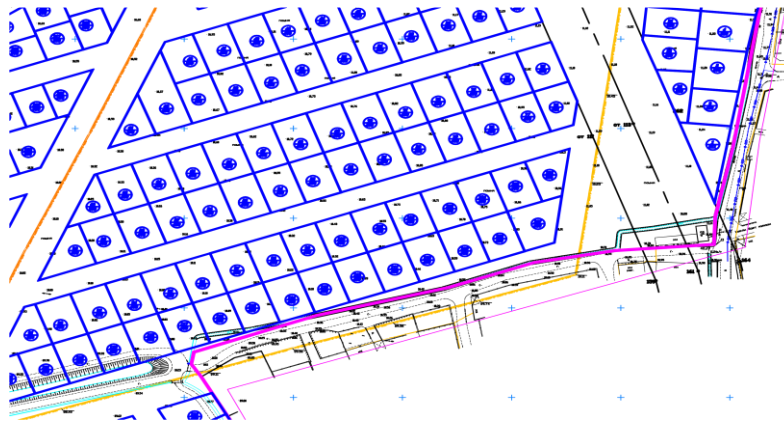

Figure 4 – Design of alignment drawing in AutoCAD Civil 3D

The use of electronic total stations and computer-aided design systems makes it possible to increase the efficiency and productivity of geodetic marking work. Regarding geodetic survey work, we can say that:

- with the help of Track light (device for setting out), you can make it easier for the rack to find the right point;

- the device provides support for numerical and graphical information on alignment work to the design point;

- it is possible to import files with project data in DXF format into the total station;

- the interactive map provides detailed information about the density of measured points around the station and the current direction of the sighting axis;

- measurements and mapping can be carried out directly from the map tab;

- calculation of the area and perimeter of figures, as well as the breakdown of a given area into figures is accompanied by a graphical representation;

- it is possible to export data in Credo DAT format;

- direct measurements and mapping from the map tab.

That the use of electronic total stations and computer-aided design systems can increase the efficiency and productivity of geodetic marking work. Regarding geodetic survey work, we can say that:

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