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Original Research Article

PLANNING AND IMPLEMENTATION OF CONSTRUCTION INVESTMENTS - THE BASIC STAGE OF WORKS

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A b s t r a c t

The subject of this article is the evaluation of geodetic and geotechnical works with the use of an appropriate program for this type of work. On the example of a selected investment in Podkarpacie, the research analyzed the validity of conducting current geodetic and geotechnical control works. It should be emphasized that most of the technical specifications do not recommend the use of this type of control work. The paper presents exemplary test results and calculations based on the software used.

Keywords: spatial planning, geodesy and geotechnical works, software of solid volume

1. INTRODUCTION

The basic legal acts in Poland are; The Act on Spatial Planning and Development [1] and the Building Law Act [2]. The Act on Spatial Planning and Development defines the goals and principles of functional and spatial division of the area. The Building Law Act applies to construction works carried out in this area. These two legal acts constitute a close synergy in the execution of the building. Despite this fact, there are deviations in the compliance of

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planning and spatial development with the construction of new buildings. This phenomenon is confirmed by the update of The Building Law Act of July 2021, as evidenced by the introduction of the legalization of unauthorized construction. In the hierarchy of spatial planning and development in Poland, planning in the commune plays the main role. At present, the basic document in communes is the Study of the conditions and directions for the development of a commune [3]. This document is the basis for the development of selected areas in the commune for local spatial development plans. The developed local spatial plan is the local law of the given commune.

The local spatial development plan for the commune contains detailed descriptive and cartographic content, on the basis of which the decisions on the building permit are issued. This plan includes, inter alia; parameters of the size of plots for development, and the types and intensity of development. On the other hand, the construction law "regulates the activity related to the construction design [2]. The purpose of the work follows from this understanding of the issue. The aim of the work is to present the basic and first stage of the activity which constitutes the foundation of the building.

2. SOIL TESTING BEFORE CONSTRUCTIONS WORKS BEGIN

The provisions of the construction law impose an obligation on the designer of the facility to obtain information on the ground conditions of the planned investment, and the detailed requirements in this regard are specified in the Regulation of the Minister of Transport, Construction and Maritime Economy of April 25, 2012. "On the determination of geotechnical conditions for the foundation of building structures" (Journal of Laws, item 463 of 2012).

The method and scope of the conducted ground research depended on the complexity of the ground conditions and the category of the designed object. Soil conditions are divided into three groups and classified as:

- simple (load-bearing soils, homogeneous)
- complex (with different load capacity, interlayer)
- complicated (e.g. on slopes, marshes, embankments, in the area of mining damage)

The scope of research also depends on including the object in one of the three categories of structures:

- Category 1 - include buildings with 1 - 2 storeys,
- Category 2 - structures with direct and deep foundations,
- Category 3 - atypical, high-rise buildings.

Depending on the correlation of this classification, the design of the building foundation requires, respectively, a geotechnical opinion, documentation of soil testing or a geotechnical design.
The actual ground conditions on the plot may be different and prior to the commencement of construction, at least preliminary soil surveys and geotechnical analysis should be carried out on the basis of e.g. archival data, opinions and observations of neighboring buildings.
In the field, soundings (test drilling) are most often carried out, and the analysis of the collected samples allows the assessment of the physical and mechanical properties of the soil. Information on the groundwater level is also obtained, which is particularly important in the case of the designed basement.
The choice of the type of foundation is the result of the construction requirements, ground conditions and the costs of their implementation [4].

3. RESEARCH METHOD AND CALCULATIONS

Proper foundation of a building object is a basic condition for ensuring the safety of a structure, therefore the foundation of each building structure must be adapted to specific ground conditions, taking into account the type of structure and the loads transferred to the ground. Any errors in the design or construction of foundations are very difficult to fix, and the related costs can be very high. Therefore, regardless of planned and conducted construction works, site visits should be made for each construction investment in order to properly develop the area for the planned investment. Therefore, it is advisable to carry out an inventory with a leveling device by drawing up a "height grid" and a land profiling project, taking into account the calculation of the volume of earthworks.

3.1. RESEARCH METHOD

Software[5] was used for the calculations. The software was created in C++ by L. Pianowski. It calculates the volume based on the method of dividing the solid into prisms on the basis of a triangle. The solid is bounded by two surfaces: the top and the bottom. They have a common edge (edge, e.g. bottom of a pile). We select characteristic points on both surfaces. Points must also be selected on a common edge (edge). The number of points depends on the shape of both surfaces, the size and the assumed accuracy of the calculated results. We connect the points on the edge of the surface into a polygon. We also connect the points on both surfaces to form adjacent triangles. After joining the adjacent points (separate on the surfaces), two mesh triangles will be created. The determining element is a prism set on the horizontal plane below the solid

(prisms) at the *Ho* level. The base of the prism is a triangle whose vertices will be projections of surface points on the horizontal plane. The volume of the prism is calculated from the formula (3.1)

$$V_i = P_t \cdot H_s \tag{3.1}$$

Where:
Vi = volume of the prism number *i,*
Pt - area of the triangle (base of the prism),
Hs - average of the height of three vertices according to equation (3.2)

$$H_s = (H_1 + H_2 + H_3)/3 \tag{3.2}$$

In order to use the program, two data sets must be prepared:
• Set 1 - a list of rectangular coordinates of the solid points (jointly for both surfaces).
• Set 2 - lists of points' numbers forming triangles, separately for each surface.
We save the data to files with whatever names (e.g. data.xy, wykop_d.pkt, wykop_g.pkt) and put them in a selected folder.
After launching the program, the following operation form is displayed
The first step to start calculations in the program is to enter the Ho reference plane level, object name, execution date and contractor, as well as the name of the file where the calculated results will be saved, e.g. Building_ Rz - ów_Baranówka.obj
The next step is to press the [Start] button to select the folder on the computer's hard drive where the data is stored and the results files will be placed. The program will display the messages: "Select set name: list of coordinates" and "Select set name: point numbers".
In the displayed system window (Opening), find and with the cursor indicate the name of the file containing the prepared data in the working folder on the hard drive.
After selecting the file, data will be entered into the program. We use the form windows and can read: Figure field lim. Bypass (polyline) Po, then volume V.
The work with the program is terminated by pressing the [Exit] button (Fig. 1).
The calculated results are saved to a file, the name of which the user enters into the form, e.g. the name of the file results.obj.

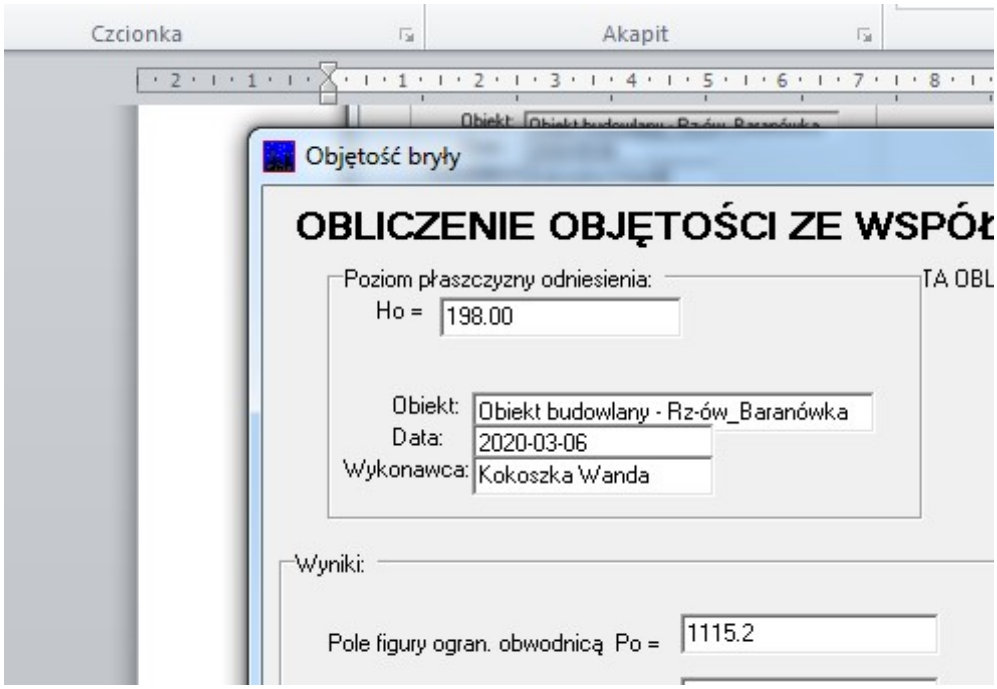

Fig. 1. Screenshot of the program's operating window [5]

3.2. CALCULATIONS

An example of the data entered for the analyzed investment under the name of Building object - Rz -ów_Baranówka.
File with the list of coordinates Construction object - Rz -ów_Baranówka.xyz, (NR X Y Z):

1 212.900 182.524 199.036 - number of point X Y Z
2 210.655 185.198 198.961
. . . . .
277 298.152 208.892 198.910
278 295.121 208.990 199.115

File with a list of the numbers of the vertices of the triangles Construction object - RzówBaranówka .nr, (NRiNRjNRk):

28 27 83 - the vertex numbers of the top surface triangle
29 28 83
85 29 83
. . . .

232 263 264
232 264 231

File with a list of the numbers of the vertices of the triangles terrain.nr, (NRiNRjNRk):
27 28 29 - the numbers of the vertices of the triangle of the bottom surface (the bottom of the solid)
27 85 29
26 27 85
. . . .
265 232 231
230 265 231

The data for the lists of numbers can be obtained from the sketch of the points. By connecting the neighboring points in the sketch, we obtain a network of triangles.
The file with the results (in the example: Construction object - Rz -ów_Baranówka.obj) also contains additional intermediate values useful in case of searching for errors after finding incorrect results.
The area *S* can be calculated independently from the coordinates of the polygon (cut contour).

Object: Building object - Rz -ów_Baranówka
Date: 2020-03-06
Realization: XXXX
1 5.4 8.6 - No., area of the triangle, volume of the prism.
2 7.1 11.5
. . . . .
183 9.1 21.4
184 10.6 15.6

S = 1115.2 m2 - the area of the polygon defined by the prism edge points,
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V = 2269.4 m^3 – the volume of the soil to be replaced (solids) is the sum of the volumes (184) of the prisms.

3.3 DISCUSSION

In the analyzed case, a large-scale facility in the Baranówka estate in Rzeszów, it was recommended that soil at a depth of 3.5m be excavated and replaced with

soil in the amount of 3903 m³; however, at the stage of geodetic works and current control of soil conditions, the soil replacement was limited to a depth of 2.0 m, and hence the volume of land replacement was reduced by 40%.

4. GEOTECHNICAL RESEARCH

In terms of geology, the research area is located within the Zapadlisko Przedkarpackie (Fig. 2)

Fig. 2. Geology of Zapadlisko Przedkarpackie [6]

The older ground here is built by clay tertiary formations with inserts of mud and sands. The ceiling of the tertiary formations lies at a depth of about 25 m. Sand and gravel sediments lie above the ceiling of the tertiary formations. They are covered with various thicknesses of a series of loess-like sediments, in this case by dust. In the research area, to the main drilling - 3m, the presence of cohesive soils was found, loess-like sediments (dusts) of aeolian origin formed in the quaternary (Holocene).

Pursuant to the Regulation of the Minister of Transport, Construction and Maritime Economy of April 25, 2012 (Journal of Laws of 2012, item 463) [7],

the ground conditions are simple, the object was classified into the 1st geotechnical category.
It should be emphasized that all decisions related to the investment process should be carefully considered, especially in the case of preparing plans related to spatial development [8-15] and undertaking geotechnical works [16-22], including geodetic works [23,24] and construction works [25-30] which is confirmed by numerous scientific and research works [31].

5. CONCLUSIONS

On the basis of the analyzed example, it should be stated that the foundation of buildings construction is sometimes related to the execution of replacement of the soil; often the planned investment cannot be started without it, since because of the undesirable parameters of the native soil (load capacity), the soil should be replaced. It also happens that activities of this type are undertaken as part of the arrangement of greenery or in connection with surface contamination of the native soil.
In the study area, in terms of geotechnics, here the older substrate is built by tertiary clay formations with inserts of silts and sands. The top of the Tertiary formations here lies at a depth of about 25 m. Sand and gravel sediments and river meadows lie directly above the top of the Tertiary formations. The sediments are covered with various thicknesses of a series of loess-like sediments, represented by dust up to the drilling depth (max. 3 m).
Dusty soil is a difficult construction substrate; very sensitive to water (Fig. 3) [31].

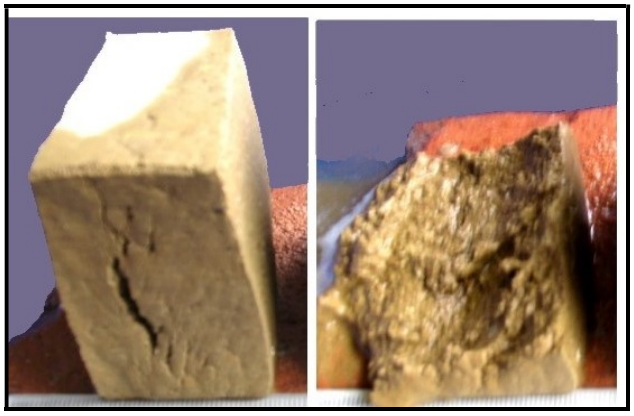

Fig. 3. Liquefaction of loess-like sediments soil under the influence of moisture [31]

Under the influence of water, loess-like are blurred, and as a result, rills and gullies are formed on their surface, and this type of damp soil becomes plastic (Fig. 4).

Fig. 4. Rills and gullies due to surficial runoff in silty soil [31]

Additionally, they are characterized by "pseudo-thixotropy", i.e. they can become plastic when wet under the influence of vibrations, and thus lose their original physical properties and load-bearing capacity.

According to the ordinance of the Minister of Transport, Construction and Maritime Economy of April 25, 2012 (Journal of Laws of 2012, item 463), the object can be classified as geotechnical category I (the foundation will not change) under simple ground conditions.

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