USING GIS FOR THE CALCULATION OF EQUALIZATION VOLUMES of HORIZONTAL PLATFORMS

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Abstract: The lands designated for construction are generally irregular facts that are leading to various constructional malfunctions. These irregularities of the land require leveling works in the form of horizontal or inclined platforms where appropriate. In order to solve these problems, it is necessary to calculate the volumes of materials to be used or dislocated in order to carry out the designed works.
Thus, the present paper aims at the efficiency of digital modeling in order to equalize a horizontal platform. By digitally modeling the data taken from topographical measurements and making use of the architectural plan, the areas most affected by the altimetry will be easily identified, these areas being subjected to correction works in order to bring them to the level of the design.

Keywords: horizontal platform, topographical survey, GIS, digital model, volume calculation

1. Introduction

In any process of build from, the combination of topographic works that run precedes, accompanies and completes the process, thereby respecting and sometimes shortening the design and execution of the whole building. The contribution of topographic works becomes even greater as the degree of mechanization of construction works and the use of modern techniques and technologies increases.

Thus, the content and importance of topographical works in the stages of study, design and execution of construction works are influenced by a number of factors such as:
- the size and configuration of the land;
- topography of the land;
- the dimensions of the building components;
- the accuracy of the topographic works necessary for the design and construction execution;
- the existence of earthworks;
- types of materials used to build the built-up assembly;
- other types of related work to be carried out;
- the deadlines for achieving the stages in the project, etc.

2. Materials and Methods

The present project has the subject of study, the ground floor of an office building under construction, designed as a horizontal platform. From the perspective of the project, the design quota must be found at every point on this platform. After casting the platform and lifting the structure, it was found that there were very high level differences which required the use of topographical measurements to determine the irregularities resulting from the construction process. As a result of the measurements, the topographic plan of the horizontal platform as well as the digital model of the platform will be drawn using the ArcGIS program.

Spatial Data Aquisition

This stage is prior to the topographical work and is imperative to establish the working tactics needed to be approached. In this phase, land recognition, positioning of the orientation and stationary points are made so as to ensure maximum efficiency in raising the details, receiving the altimeter value of the reference point considered as the "0" elevation of the platform and clearly establishing the areas of interest in the objective.

The positioning of the constituent points of the lift network is determined by consulting the projected plan of the hall to ensure optimal positioning and mutual visibility. By making use of the existing plan, it is the ideal place to place the points for preservation.

Fig. 1 Designed Hall Plan

Design of the topographical network and surveying

The topographic network used was materialized using MessPunkt topographic bullets arranged to provide a line of observation of at least 3 points. The topographic elevation was executed with the total Rec Elta 15s station in order to determine the coordinates of the detail points.
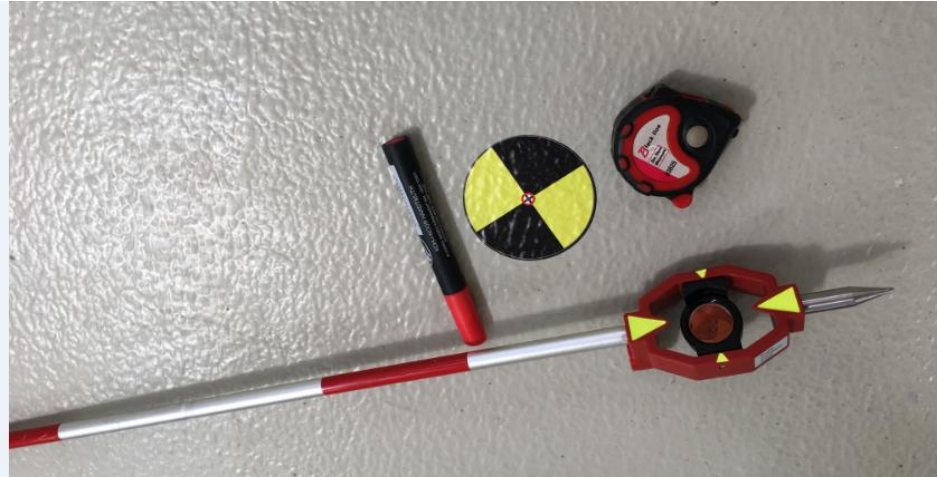

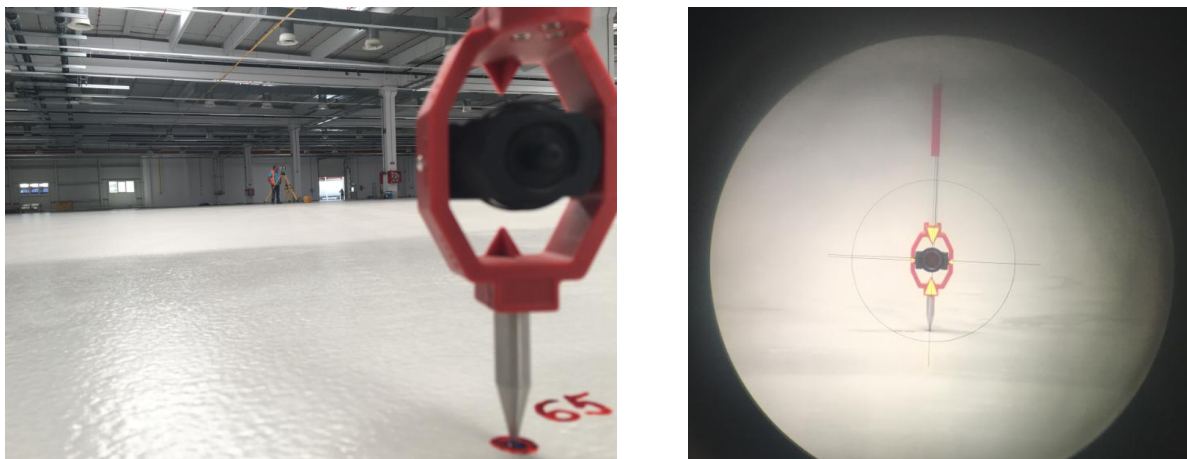Fig. 2 The materialization of topographical points

Fig. 3 Realizing the topographical measurements

3. Results and Discussion

Data Processing

The precursor phase of digital modeling is the framing of measured points within the building perimeter by overlapping topographic points over the architectural plan using AutoCad Map 2016 and creating level curves in a local altimetric system based on the platform design share.

Creating level curves is performed using the TopoLT program, which has the role of demarcating areas with the same share, and highlights the distribution of these areas of interest on the surface of the platform.
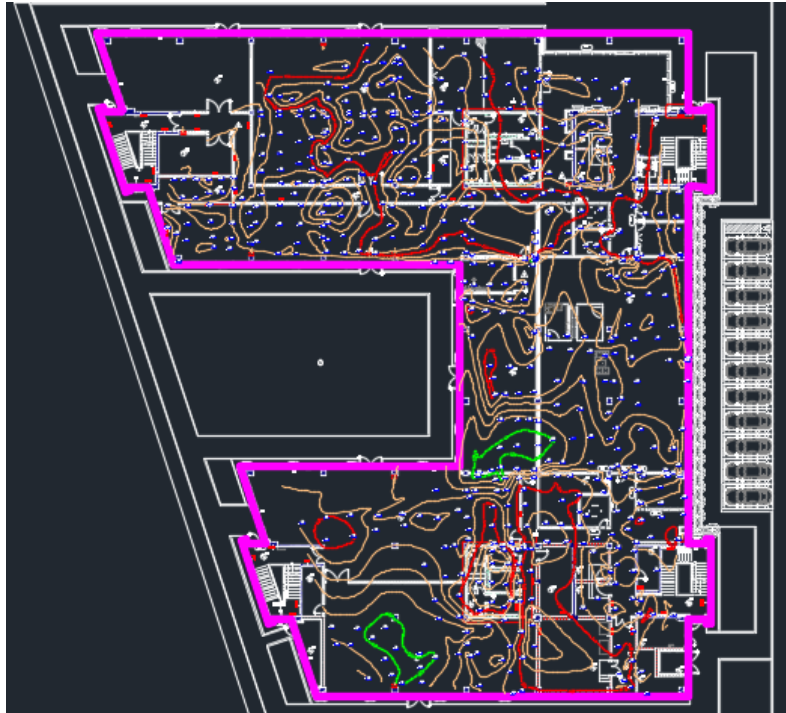
Fig. 3 Topographic plan including level curves on platform surface

The topographic plan obtained in the CAD application has a fundamental role in the elaboration of the equalization strategy of the platform, either unitary or in rooms, according to the needs of the beneficiary.

After the analysis of the resulting topographic plan it is observed that the values of the levels of the level curves are varied in relation to the design quota, these being created in order to highlight the most affected areas in terms of the deviation from the establish quota of project.

The integration stage of the data in the informational sistem

The pre-stage of CAD integration in the GIS environment is to edit the digital model in the AutoCAD 2016 program to remove the details that are not subject to the proposed modeling but which crowd the graphic representation:
- furniture;
- networking;
- fire prevention systems;
- utilities, etc.

Integration of data from measurements in GIS application, we use coordinates inventory from processing measurements. Thus, the topographical points will be located in the perimeter contour of the building, these being the planimetric and altimetric data frame after which the digital model will be blown.

Subsequently, the layout of the building, including the walls and columns, will be added, these being the data pool and then creating the polygon that will serve as a template in the data processing stage. In the cartographic editing stage of the spatial elements, the snapping mode will be activated in order to precisely trace the contour of the building.
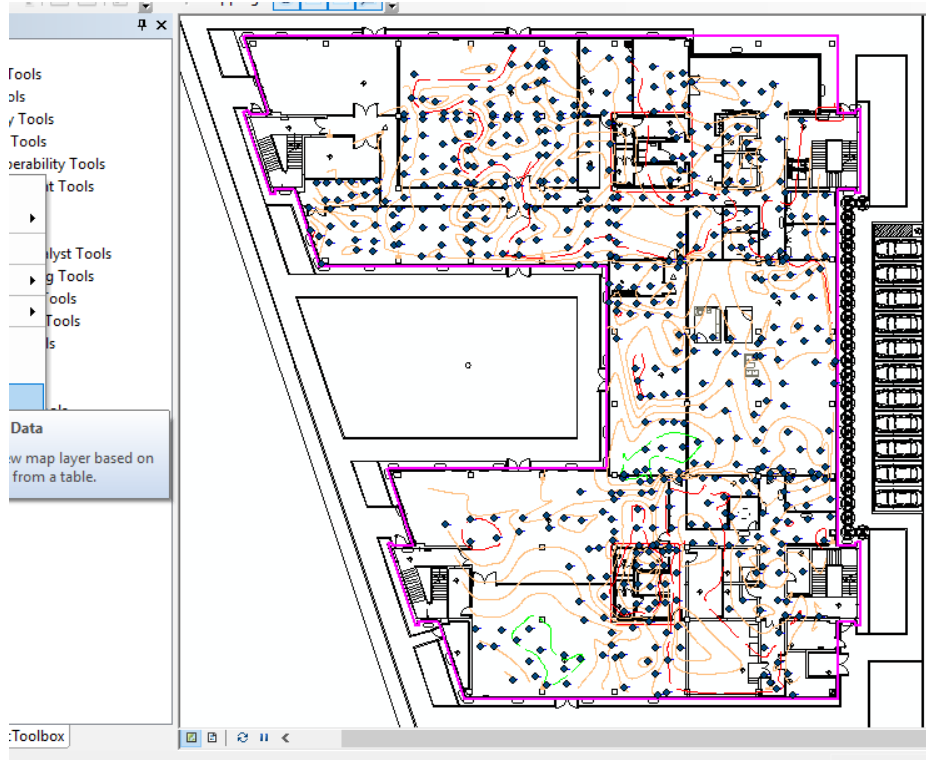
Fig. 4 Data Integration in Information System

Data Processing

Data processing in the GIS application involves the creation of polygonal shape structures that replicate the construction footprint, the integration of the topographic points obtained from the measurements and the creation of the digital model that reflects the real situation in the field.

To create the structure, we will make use of the ArcCatalog tree, selecting the target folder and creating the shapefile structure. To create the digital model we use the layout of the building as the data frame. Also, only elements that have a footprint (pillars and wall voids) will be exported from the CAD environment.
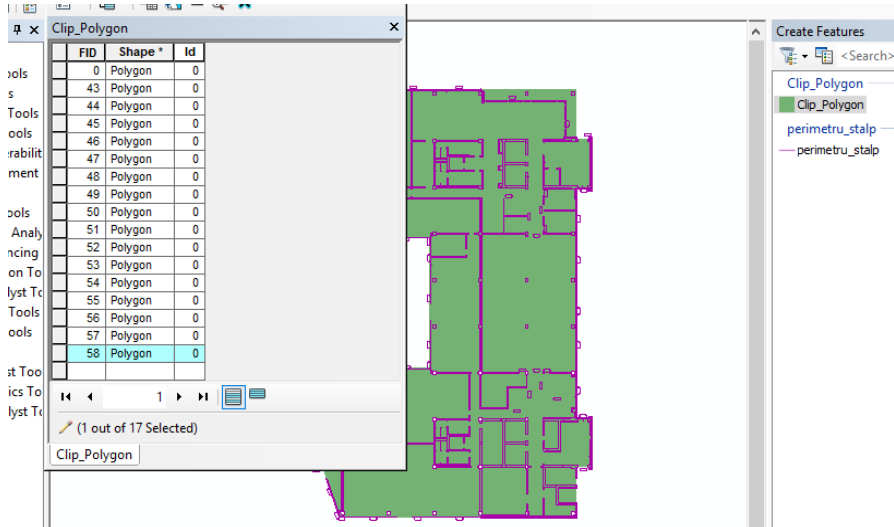

Fig. 5 Cartographic editing of elements in the GIS

For mapping, spatial editing will be started with the polygon created and the addition of vertex elements to the ground footprints of the building, walls and columns because the digital modeling is the platform's useful surface. After the mapping data, it will be delete the enclaves, these being represented by the pillars and the walls, which will not be included in the calculation of the filling volume.

Digital Modelling

Digital modeling involves creating a TIN model that faithfully reflects the situation on the ground. The data in order to create the digital model is represented by inventory coordinate and polygon entity created earlier.

In order to calculate the fill volume, two such models will be created as follows:
-    1 digital model that reflects the real situation;
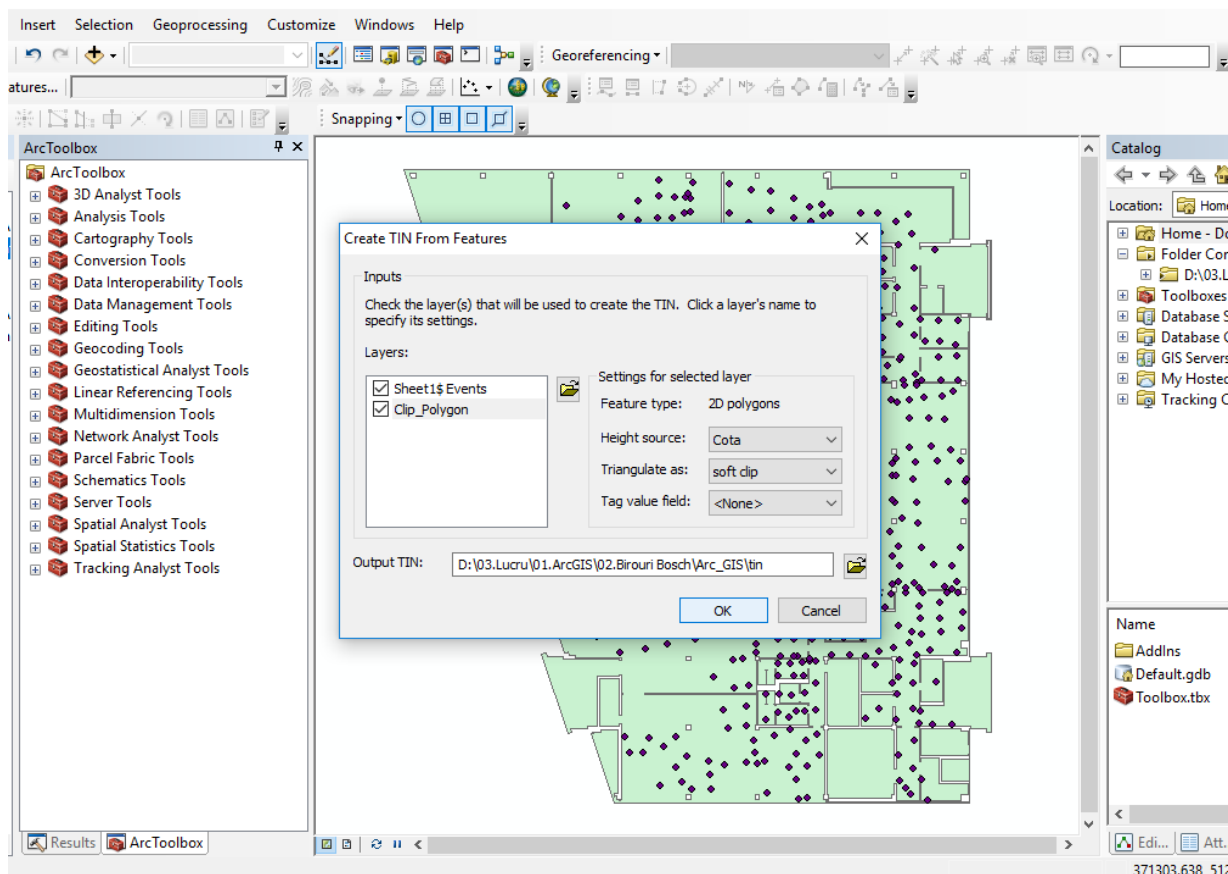-   1 digital model with a project quota.

Fig. 6 Creating the Digital Model

Calculation of difference volumes

For volume calculation of stuffing material will be create a new digital model based on the same polygon structure but with a constant elevation over its entire surface, this dimension being the absolute altimeter value of the radier share, being considered the digital reference model.

After obtaining the second model, a volume difference will be performed between the referenced model and the digital model obtained from the data processing from the

topographic measurements. The obtained result consists of a composite vector structure in which three distinct types of surfaces are distinguished according to their vertical position:

- area over the contact area;
- area with identical shares;
- area with odds below the value of the contact area.

It should be noted that the highlighted contact area with a polygonal structure was a source of data in generating a unique TIN model, thus, it was possible to make the difference between the structures of the two digital models.

After calculating the difference between the digital model of the projected quota and the digital real estate model in the field, a volume of $31,139 m^3$ was obtained which represents the difference between the current situation and the proposed ideal.
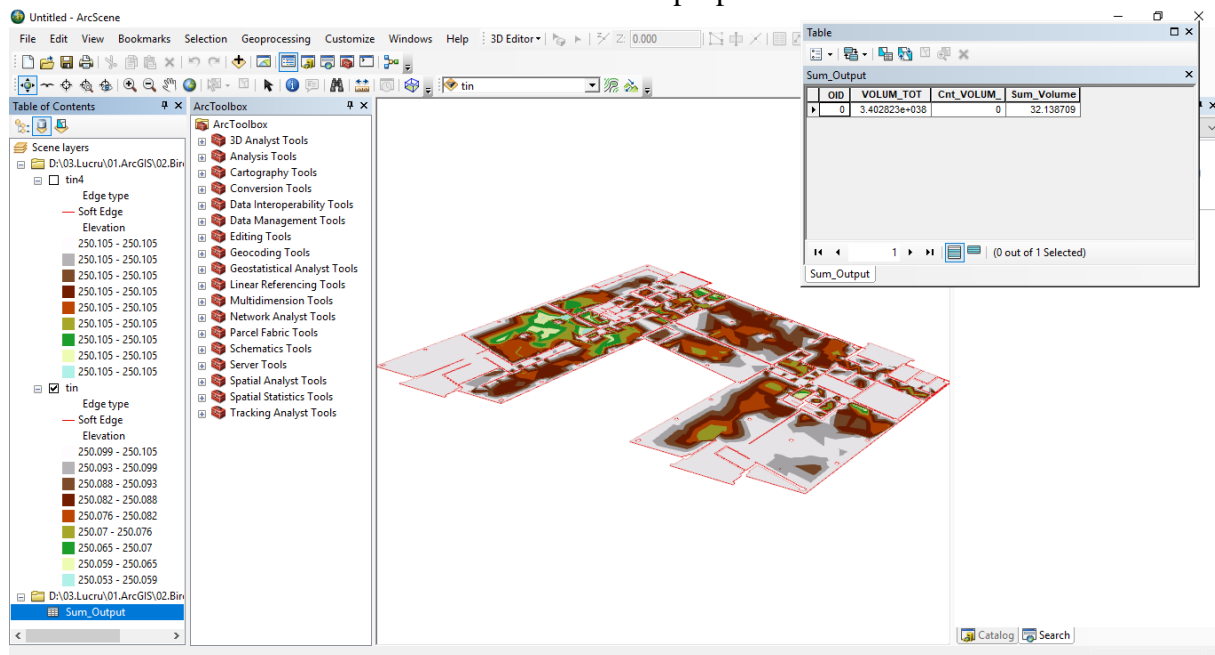

Fig. 7 The end result of modeling

Based on the result obtained, it was possible to calculate the equalization cost of the platform.

On the basis of an estimate of the financial costs related to the volume of construction material required for the equalization of quotas within the horizontal platform, it follows:

- $32 m^3 = 6$ concrete trucks, including associated losses;
- 6 concrete trucks x 2,000 Lei / per concrete truck = 12,000 Lei (final cost of material).

This resulting cost is simply estimated, depending on the type of equalizing material (concrete / self-leveling screed / epoxy resin, etc.), plus the costs of carrying out the necessary leveling works.

4. Conclusions

The design and construction of a building can not be done without the use of topographic plans appropriate to the realities of the field. The field application of the project is based on topographic methods and tools.

Also, in the construction exploitation process, starting from its reception and continuing with the observation of the behavior over time, it is constantly appealing to the

topographical works, so the topographer accompanies the construction during its entire lifetime. Based on these considerations, all aspects of project preparation and approval, general building technology, milestones and work required during construction exploitation must be known.

Concluding, we can mention that the topographer must be an active factor in the design and execution of all engineering objectives. Also, using digital modeling to address this issue, we can solve technical issues in the field by using dedicated software, thus satisfying the needs of the customer and resolving issues of this nature quickly and efficiently.

Finally, the digital model obtained closely reflects the situation on the ground and helps to accurately calculate the amount of material needed to equalize the platform in question.

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