LAND SURVEY WORKS FOR THE CALCULUS OF VOLUMES IN DIFFERENT ASSORTMENTS OF MINERAL AGGREGATES IN TIMISOARA, ROMANIA

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Abstract

Topographic surveys whose results are presented in this paper were made in Timisoara, Timiş County, Romania. Topographic measurements aimed at calculating the volume of different sorts of mineral mine ballast aggregates such as sand 0-4, broken stones 4-8, broken stones 8-16, broken stones 16-32. Topo-cadastral measurements were made with a GPS equipment from Leica 1200 Series, and apparatus downloading and data processing were done with a LEICA Geo Office Combined Programme. Data processing aiming at developing a 3D model was done with a TopoLT software, and the GRID model of the amounts of mineral ballast aggregates as well as the volume calculus were done with a Surfer 8.0 software produced by Golden Software.

Measurements were made with ROMPOS (Romanian System for the Determining of the Position), a project of the National Agency for Cadastre and Real Estate, to ensure accurate reference positioning and ETRS European coordinates through the Permanent GNSS National Network Station.

ROMPOS relies on GNSS (Global Navigation Satellite Systems) (future GPS/GLONAS/GALILEO), supplying data for positioning goals to improve the precision of a position up to an order of one millimetre.

The permanent GNSS Station used to produce the results presented in this paper is the one in Timişoara, Timiş County, Romania.

Key words: land survey works, volume calculus, GRID model, Leica Geo Office Combined, Surfer, mineral aggregates.

INTRODUCTION

The Global Navigation Satellite System (GNSS) uses the positioning technique for static or moving items at any time, no matter its place on Earth – in water or air. It supplies current information in real time, with precise solutions for safe navigation.

A Global Positioning System (GPS) is a GNSS sub-system through satellites used only to supply information necessary to determine the position of some points on earth. In the land survey and geodesic field, applying GPS technology allows the identification of the coordinates of some receiver antennae usually set in different points of a geodesic network.

GPS is, therefore, a system due to which, starting from mobile points along the satellite orbits, one can determine the position of a point no matter where on Earth. Hence, the reference system should be geocentric, unique for the entire Earth, and fixed as far as Earth's movement is concerned. The system adopted for GPS complies with the World Geodesic System 1984 (WGS'84).

MATERIAL AND METHOD

The topographic elevations for this paper were performed with Leica GPS 1200, a very powerful device with many applications and functions that can satisfy the requirements of users worldwide.

In this paper, we used the RTK (Real Time Kinematic) method to make the measurements, using the reference station at Timisoara – TIM1_2.3

The collected data can be exported directly by the GPS1200 receiver, but for the present paper, they were downloaded with the ***Leica Geo Office Combined*** programme.

The GPS reference system is **WGS 84** (World Geodetic System 1984) that, like the ITRF system, is defined by the coordinates of the determined terrestrial points.

The ***TransDatRO 4.01*** software application is a transformation procedure similar to other international procedures. It embeds a spatial data distortion model in order to maintain spatial data integrity and topology in each datum. As a result, points with larger distortions are not eliminated. On the contrary, they are tested and included in the transformation, in order to describe as realistically as possible the characteristics of each area containing new points awaiting transformation.

Having processed the data and changed the coordinates from ETRS89 to STEREO70 with the ***TransDatRO 4.01*** application, the volumes were calculated based on the 1970 stereographic coordinates obtained with SURFER 9.0 and TopoLT.

Surfer is a very complex product of *Golden Software,* a company that specialises in computer graphics. It is very effective in making digital maps. The spatial terrain model is based on the points with the X, Z, Y coordinates registered in ASCII-type files with *.DAT* extension. Based on these coordinate points that are disposed on the surface of the whole spatial model that is to be created, a network of points with X, Z, Y coordinates of GRID type is created (it is a grid-type network). The network has a certain point density that is registered in GRID-type files with .GRD extension.

RESULTS AND DISCUSSION

Grid volume report with surfer

When Grid Volume computations are performed, the results are displayed in the grid volume report.

The volume computations in the **Grid Volume Report** dialog include the following:

Upper Surface and Lower Surface

These sections display the parameters that define the upper and lower surfaces.

Volumes

The volume is calculated by three methods: Extended Trapezoidal Rule, Extended Simpson's Rule, and Extended Simpson's 3/8 Rule. The reported volume is the sum of the Positive Volume (Cut) and Negative Volume (Fill). The *Z Scale Factor* is also reported in this section.

The *Positive Volume (Cut)* is the volume of material in those places where the upper surface is above the lower surface. The *Negative Volume (Fill)* is the volume of material in those places where the upper surface is below the lower surface. The *Cut Minus Fill* is the difference between the cut and fill volumes. See Cut and Fill Volumes for more information on cut and fill.

Areas

The *Areas* section reports both planar areas and surface areas. The *Positive Planar Area* represents the planar area where the upper surface is above the lower surface. The *Negative Planar Area* represents the planar area where the upper surface is below the lower surface. The *Blanked Planar Area* is the sum of the areas over the blanked regions on both the upper and lower surfaces. The *Total Planar Area* represents the planar area for the entire grid. Where two surfaces coincide exactly, the area of coincidence is reported as part of the *Positive Planar Area*.

The *Positive Surface Area* represents the area of the surface where the upper surface is above the lower surface. The *Negative Surface Area* represents the area of the surface where the upper surface is below the lower surface.

Net Volume

The volume calculation determines the net volume between the upper and lower surface. The net volume is reported in the *Volumes* section of the Grid Volume Report. See Cut and Fill Volumes for more information on the upper and lower surface.

To visualize net volume, consider a construction site where the topography must be graded to a flat surface prior to the beginning of construction.

1. SAND 0-4

<u>Grid Volume Computations</u>

Upper Surface

X Minimum: 473389.1908
X Maximum: 473400.6646
X Spacing: 0.11951875000038
Y Minimum: 202397.2916
Y Maximum: 202409.1585
Y Spacing: 0.11986767676761
Z Minimum: 85.681221044605
Z Maximum: 89.605302875498

Lower Surface

Level Surface defined by Z = 86.1441

Volumes

Z Scale Factor: 1

Total Volumes by:

Trapezoidal Rule: 203.89010509253
Simpson's Rule: 203.89376782526
Simpson's 3/8 Rule: 203.89413716781

Cut & Fill Volumes

Positive Volume [Cut]: 210.48395613428
Negative Volume [Fill]: 6.593021492995
Net Volume [Cut-Fill]: 203.89093464129

Areas

Planar Areas

Positive Planar Area [Cut]: 110.31799186081
Negative Planar Area [Fill]: 25.840445359548
Blanked Planar Area: 0
Total Planar Area: 136.15843722036

Surface Areas

Positive Surface Area [Cut]: 123.67270961943
Negative Surface Area [Fill]: 26.127705256012

SAND 0÷4, Volum: 203 mc

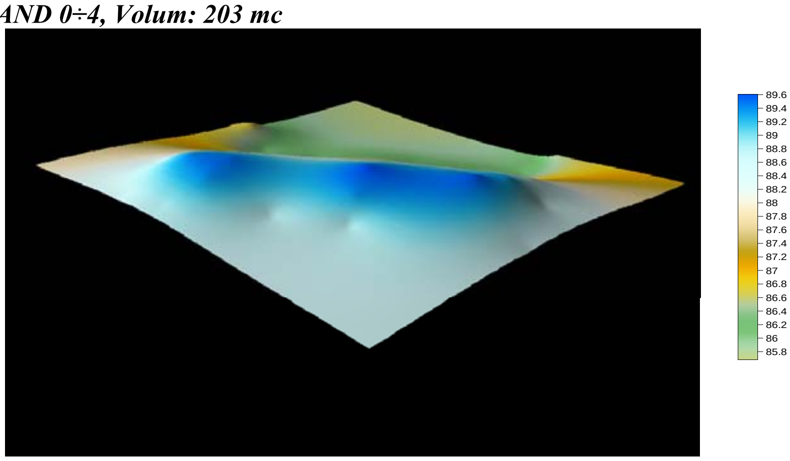

Fig. 1. The SURFER V8.0 model, *Sand 1 0÷4, volume: 203mc*

2. BROKEN STONES 4-8

Grid Volume Computations

Upper Surface

X Minimum: 202405.4587
X Maximum: 202415.2262
X Spacing: 0.10502688172061
Y Minimum: 473385.494
Y Maximum: 473395.8927
Y Spacing: 0.10503737373757
Z Minimum: 85.804844069748
Z Maximum: 89.065056084531

Lower Surface

Level Surface defined by Z = 86.1854

Volumes

Z Scale Factor: 1

Total Volumes by:

Trapezoidal Rule: 163.83933073082
Simpson's Rule: 163.84270043845
Simpson's 3/8 Rule: 163.84274490771

Cut & Fill Volumes

Positive Volume [Cut]: 165.93354859493
Negative Volume [Fill]: 2.0932692056218
Net Volume [Cut-Fill]: 163.8402793893

Areas

Planar Areas

Positive Planar Area [Cut]: 90.441514963847
Negative Planar Area [Fill]: 11.127787286515
Blanked Planar Area: 0
Total Planar Area: 101.56930225036

Surface Areas

Positive Surface Area [Cut]: 97.679745885555
Negative Surface Area [Fill]: 11.257671962791

BROKEN STONES *4÷8, Volum: 163 mc*

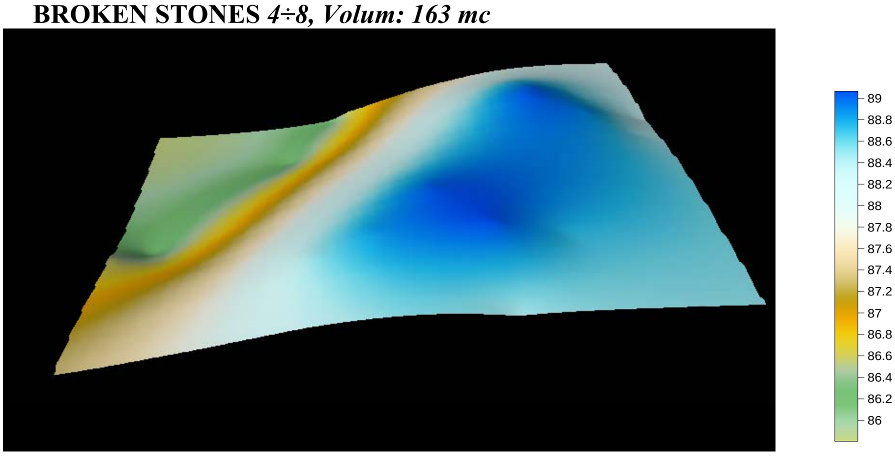

Fig. 2. The SURFER V8.0 model, *Broken stone 2 4÷8, volume: 163mc*

3. BROKEN STONES 8-16

<u>Grid Volume Computations</u>

Upper Surface
X Minimum: 473377.5514
X Maximum: 473386.3732
X Spacing: 0.096942857142594
Y Minimum: 202418.483
Y Maximum: 202428.0795
Y Spacing: 0.096934343434193
Z Minimum: 85.904204233848
Z Maximum: 89.009934999826
Lower Surface
Level Surface defined by Z = 86.2222
Volumes
Z Scale Factor: 1
Total Volumes by:
Trapezoidal Rule: 133.99977311846
Simpson's Rule: 134.00289637832
Simpson's 3/8 Rule: 134.00312390646
Cut & Fill Volumes
Positive Volume [Cut]: 135.29315579431
Negative Volume [Fill]: 1.2928446587123
Net Volume [Cut-Fill]: 134.0003111356
Areas
Planar Areas
Positive Planar Area [Cut]: 76.437299322184
Negative Planar Area [Fill]: 8.2211043774547
Blanked Planar Area: 0
Total Planar Area: 84.658403699639
Surface Areas
Positive Surface Area [Cut]: 83.284483905364
Negative Surface Area [Fill]: 8.3864086652315

BROKEN STONES *8÷16, Volum: 134 mc*

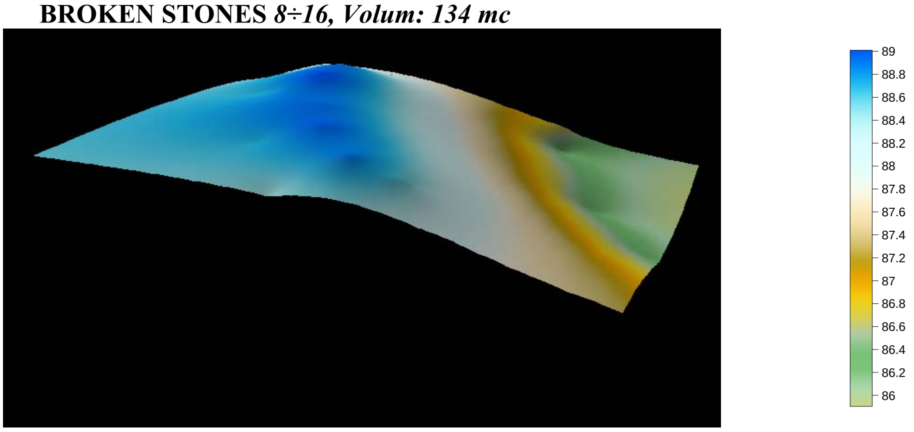

Fig. 3. The SURFER V8.0 model, *Broken stone 3 8÷16, volume: 134mc*

4. BROKEN STONES 16-32

Grid Volume Computations

Upper Surface	
X Minimum:	202411.8663
X Maximum:	202423.6854
X Spacing:	0.13430795454538
Y Minimum:	473381.6328
Y Maximum:	473394.9942
Y Spacing:	0.13496363636358
Z Minimum:	85.677562768468
Z Maximum:	89.33720800586
Lower Surface	
Level Surface defined by Z = 86.1766	
Volumes	
Z Scale Factor:	1
Total Volumes by:	
Trapezoidal Rule:	302.14692708889
Simpson's Rule:	302.16013150271
Simpson's 3/8 Rule:	302.15981493306
Cut & Fill Volumes	
Positive Volume [Cut]:	304.46557859131
Negative Volume [Fill]:	2.3164930051419
Net Volume [Cut-Fill]:	302.14908558617
Areas	
Planar Areas	
Positive Planar Area [Cut]:	147.64545874126
Negative Planar Area [Fill]:	10.274263998583
Blanked Planar Area:	0
Total Planar Area:	157.91972273984
Surface Areas	
Positive Surface Area [Cut]:	157.35642993035
Negative Surface Area [Fill]:	10.499667706557

BROKEN STONES *16÷32, Volum: 302 mc*

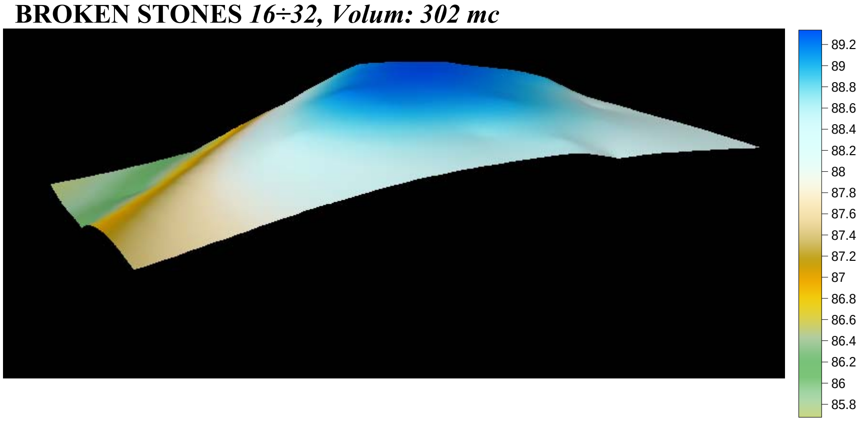

Fig. 4. The SURFER V8.0 model, *Broken stone 4 16÷31.5, volume: 16-32*

CONCLUSIONS

The data can be exported directly by the GPS1200 receiver but for the present paper, we downloaded data with a ***Leica Geo Office Combined*** programme.

The reference system of the GPS is **WGS 84** (World Geodetic System 1984) that is defined, as the ITRF system, by determined land point coordinates.

Information from measurements is stored on a ***Compact Flash*** card. Downloading is done with a ***Compact Flash*** card connected to a card reader and with a ***Leica Survey Office Combined*** programme, easy to use for both downloading the job and for uploading the job.

After creating and naming the new project, we choose the coordinates used. If there are other parameters calculated, we can choose them from the list and choose coordinates transformation parameters. In this case, transforming the coordinates WGS84 into stereographic coordinates 1970 is done directly from ***Leica Geo Office Combined*** without processing the file ***Timişoaara, Timişoara.txt*** that was saved and introducing the file ***Volumes Timişoara, Timişoara.txt*** into the programme ***TrasDatRO 4.01*** for coordinate transformation. After these steps, we click the OK icon and the newly created project ***Volumes Timişoara*** is on the list with created projects.

The next step is to import data from the apparatus card using the command ***Import Raw Data***.

After importing data, the coordinates thus obtained are displayed in the WGS84 system that we present partially below.

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