TECHNICAL CONSIDERATIONS REGARDING THE USE OF GPS TECHNOLOGY TO IMPROVE TELECOMMUNICATION INFRASTRUCTURE

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Abstract: *This paper aims at studying the location of an FM Radio Antenna outside Jebel, Timiş County, Romania. At present, the land is considered ARABLE according to an excerpt from the Real Estate Office no. 403328, issued by the O.C.P.I. Timiş. It concerns the location of a metal pole 51 m high with bars to support radio equipment and it was designed to enlarge the coverage area. The tower was designed to resist strong pressure from wind. The pillar is a metal structure made up of 17 pole segments 3 m each. The segments are triangular and made up of three round pipes installed at 120^0. The pipes are stiffened with counter-winds. Once installed and positioned, the pillar will be anchored on the six foundations F2 with steel cables 8 mm diameter, according to the elevation plan. The pillar has as a foundation a bushing of armed steel measuring 1x1x0.9 m in height; it is supported by a concrete block measuring 1.4x1.4x0.7 m. the anchoring of the pillar will be done with six anchoring cables on the six F2 foundations according to the plan. Anchoring cables are of steel Ø8; they will be mounted together with the pillar. The cables will be tensioned at 1 KN. The entire metal collection will be galvanised in the workshop. The first and last three segments of the pillar will be red and the other ones will be white and red alternatively. The site will not produce smoke or artificial fog as described in the Building regime. Works will be done in three steps: Step 1 – ensuring the precinct; Step 2 – infrastructure (de-covering, digging and foundations); Step 3 – supra-structure (mounting the metal pillar). Land survey was done in the field with GPS equipment from Leica, series 1200; the apparatus was downloaded with a Geo Office Combined Leica Programme; the coordinates WGS 1984 were turned into Stereographic 1970 coordinates with the programme TransDatRo; and data were processed with the programmes TopoLT and AutoCAD 2014.*

***Key words*:** *FM Radio Antena, OCPI, GPS, TransDatRO, WGS 1984, Stereografic 1970, TopoLT, ACad*

INTRODUCTION

According to Law no. 50/1991 regarding the licensing of building constructions, construction works are allowed only based on a building or destruction authorisation. This authorisation is issued upon request from the owner of the property title of a real estate – land and/or buildings – or upon another document conferring the right to build or destroy under legal conditions.

Civil and industrial constructions, including those for the support of installations and technological, agricultural or otherwise equipment can be done only observing the building authorisation issued under legal conditions and the regulations regarding the design and execution of the buildings.

The building authorisation is the authority document issued by the local public administration that underlies the application of legal measures regarding the location, design, execution and functioning of the buildings.

Building authorisations for major networks, routes of communication, land improvement works, telecommunication networks or other infrastructure works within and outside the localities are issued observing land planning plans acknowledged and approved legally.

According to the standards for the infrastructure of communication routes from October 7, 2015, the following should be taken into account:

Constructive and technical features for communication networks with radio support:

- TOWERS are self-bearing buildings made up of segments of 6, 7 or 8 m (currently, 6 m) of steel pipes;
- The segments are triangular or square in section depending on the height and on soil nature determined geo-technically;
- Towers are placed on a foundation (infrastructure) made of armed steel;
- PILLARS are made of OL steel whose diameter depends on weight and height and that is set on an armed steel infrastructure;
- Pillars are anchored structures;
- Resistance depends on the nature of the soil determined geo-technically;
- Location of towers and pillars is done on lands free of any other charges (installations that need re-location).

Outside localities:

- Pillars or towers are located outside the safety area, no matter the category of the roads.

Inside localities:

- Pillars or towers are located within precincts or on top of the buildings observing the standards regarding building resistance;
- Equipment associated with towers or pillars is installed within buildings or shelters located at the basis of the towers or pillars;
- Installing cables for inter-connection will be done according to constructive requirements.

According to the stipulations of the Law no. 50/1991 regarding quality in the constructions, with later changes and additions, the structure project is checked from the perspective of the requirements "A1" ("Resistance and stability for civil, industrial and agricultural constructions whose structure is made of armed concrete, masonry and wood") and "A2" ("Resistance ad stability for civil, industrial and agricultural constructions whose structure is made of metal").

The technical decision attests the conformity with normative stipulations, with technical documenting for the design, decision and achievement of systematised routes of electronic communications, as well as for the authorisation of infrastructure works of public networks of electronic communications, including the Coordinating decision for such works.

Technical documenting will be done in accordance with the stipulations of the Law no. 50/1991 and of the Methodological norms for the enforcement of the Law no. 50/1991 regarding the authorisation of construction works approved by Order of the Minister of regional development and lodging no. 839/2009 with later changes and additions.

MATERIAL AND METHODS

For the land survey of the area, we used GPS equipment from Leica series 1200, an apparatus with multiple applications. The GPS series 1200 can be used as either reference station, or as rover for both static and kinematic measurements (RTK).

This apparatus can also be sued together with classical land surveys and in seismic tracing, monitoring, and measuring. GPS series 1200 receivers are designed to work in the hardest conditions and they can endure drops and vibrations, operate while raining or snowing at temperatures between -39^0C and $+64^0$C.

In this study, for GPS measurements, we used the ***RTK Method (Real Time Kinematic)*** using the reference station in Timisoara, ***TIM1_2.3***. The measuring engine we used is of the ***SmartTrack*** type: it reaches satellites in just a few seconds. The antenna is of double frequency of the ***GX1230*** type with cu SmartTrack and it supports signals ***GLONASS***, ***GPS L15*** and ***GALILEO***. Leica GPS1200 has a keyboard of the ***QWERTY*** type, touch screen or not; preferably, one can visualise the survey directly in the field. Raw data can be exported directly with the ***GPS1200*** receiver, but in this case, we downloaded data with a ***Leica Geo Office Combined*** Programme. The reference system of the GPS is ***WGS 84 (World Geodetic System)***.

Turning raw data (***RAW DATA***) from the ETRS89 system into the STEREO'70 system was done with the application ***TransDatRO***, and then we reported the points in ***AutoCAD*** with the ***TopoLT*** Programme functioning under the ACAD platform.

The transcalculus of coordinates from the reference system ETRS'89 into the Stereographic'70 system was done with the soft TransDat 4.01 produced by A.N.C.P.I.

The permanent GNSS station used in measurements at Timisoara – TIM1_2.3, RTCM-Ref 0000 had the coordinates in Table 1 below:

Table 1

GNSS permanent station for measurements

ELLIPSOID COORDINATES – ETRS89				
Name of permanent station	Class	B[m]	L[m]	He[m]
Timisoara (TIM1_2.3)	A	45° 46' 47.65271" N	21° 13' 51.46281" E	154.7278 m
STEREOGRAPHIC COORDINATES 1970				
Name of permanent station	Clasa	X(m)	Y(m)	Z(m)
Timisoara (TIM1_2.3)	A	482495.226	207132.378	111.33

Ellipsoid coordinates that can be turned within the programme are the ones obtained by connecting to the national geodesic network (RGN) class A, without having to station the triangulation points. Thus, the resolution of turning new points depends largely on the current

situation of the number and display of the common coordinate points over the national territory.

- Planimetrically (coordinates X and Y), there is resolution: all the points were obtained with a resolution between 2 and 4 cm, below the imposed value (5 cm on the coordinates X and Y);
- Altimetrically, the quotas obtained by GPS measurements reached such an imposed value ranging between 3 and 5 cm.

The points resulted from their transformation from the WGS 1984 system into the STEREOGRAPHIC 1970 reference system were reported in the AutoCAD to link the points and edit the situation plan.

RESULTS AND DISCUSSIONS

To do this work, we land surveyed in the WGS 1984 projection system on the plot no. 403328 (Figure 1) to design the situation plan at the scale 1:1000 according to current technical norms, coordinates that were turned with the programme TransDat4.0 into Stereographic 1970 coordinates, with a level reference system MAREA NEAGRĂ 1975.

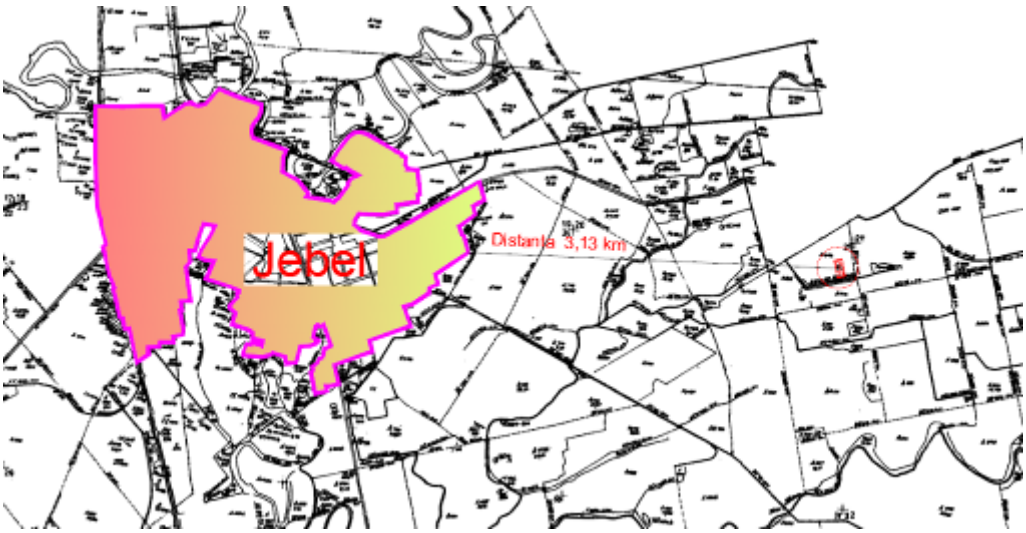

Figure 1 - Area framing plan of Jebel, Timiș County

The plot with the cadastral no. 403328 measuring 10,000 m^2 is recorded in the Real Estate Office under no. 403328 and is located outside Jebel, Timiș County.

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The plot no. 403328 resulted from the dismemberment of the building no. 403075, old no. A843/1/4 measuring, before dismemberment, 28,460 m^2. The dismemberment of the building no. A843/1/4 produced two new plots: LOT 1 measuring 18,460 m^2 and LOT 2 measuring 10,000 m^2; the latter plot no. 403328 is the subject of the work presented here.

In the present work, we used the kinematic method RTK in real time using in real time differential corrections from the specialised service ROMPOS.

To carry out this work, we used the GPS Leica 1200 apparatus. Data processing was done with the soft Leica Geo Office Combined; then, the points calculated were reported into the AutoCAD that served to the situation plan. The calculus of the areas was done analytically.

In this work, we used:

- Situation plan, scale 1:1000;
- Area framing plan, scale 1:10000.

To determine the GPS station points, we used the Stop&Go Method (or Real Time Kinematic) using the reference station TIM1_2.3 from Timisoara.

For land surveying, we did the following:

- Identifying the land;
- Measuring with the total station Leica TC 805;
- Measuring with a GPS (Global Positioning System) through the kinematic method RTK (Real Time Kinematic) using the reference station in Timișoara;
- Downloading the apparatus with the Leica Geo Office Combined Programme;
- Processing raw data;
- Using the programme TransDat 4.0 for the transformation from the system WGS'84 (World Geodetic System) into the Stereographic 1970 system;
- Processing data;
- Importing points in AutoCAD with the programme TopoLT;
- Linking the points and editing the situation plan, scale 1:1000.

The coordinate system:

- This work was done with the STEREOGRAPHIC Projection System 1970 and with the level reference system MAREA NEAGRĂ 1975 (Figure 2).

This paper is the project for the building authorisation of an anchored pillar for a metal antenna 51 m tall. The main pillar (Figure 3) is a metal structure made up of 17 segments of pole 3 m each (Figure 4). The pole segments are triangular and are made of three round pipes at 120^0. The pipes are fixed with counter winds. One mounted and erected properly, the main pillar F1 will be anchored on the six foundations (Figure 5) with steel cables (Figure 4) 8 mm in diameter.

The pillar F1 relies on an armed concrete bushing 1x1x0.9 m supported by a plain concrete block 1.4x1.4x0.7 m. Pillar anchoring will be done with six anchorage cables on the

six F2 foundations. Anchoring cables will be made of steel Ø8 and cables will be mounted with the pillar. Cables will be pre-tensioned 1 KN.

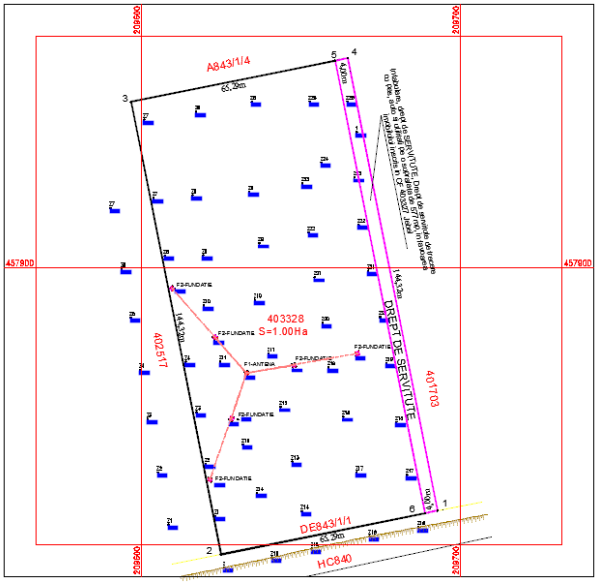

Figure 2 - Situation plan for the building no. 403328, Jebel, Timiş County

The entire metal confection will e galvanised in the workshop. The first and the last three segments of the pillar will be red, while the other segments will be white and red alternatively.

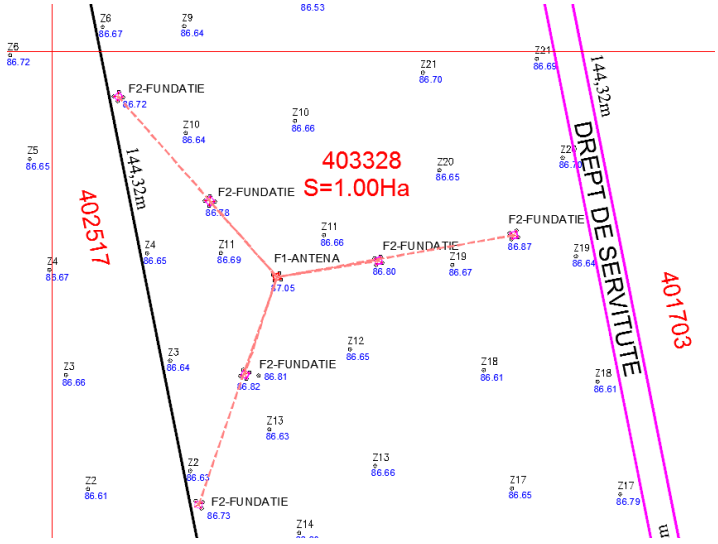

Figure 3 - Situation plans for the foundations F1 and F2

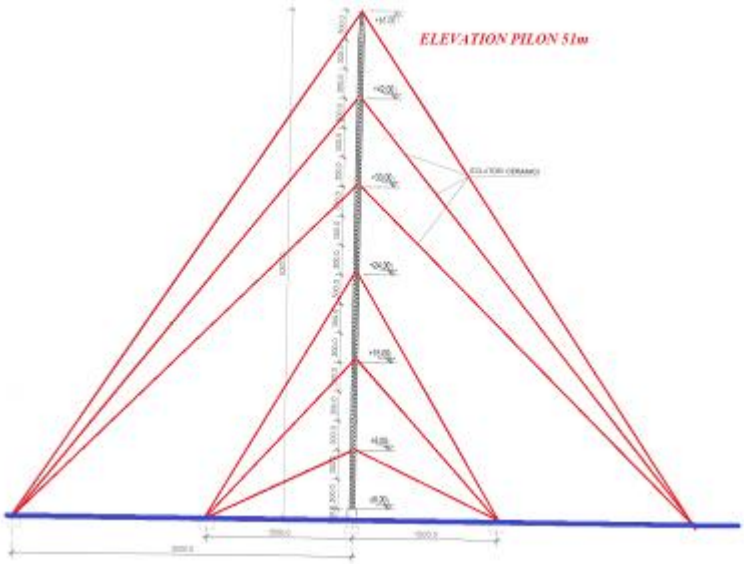

Figure 4 - Elevation of the pillar of 51 m for the Radio Antenna

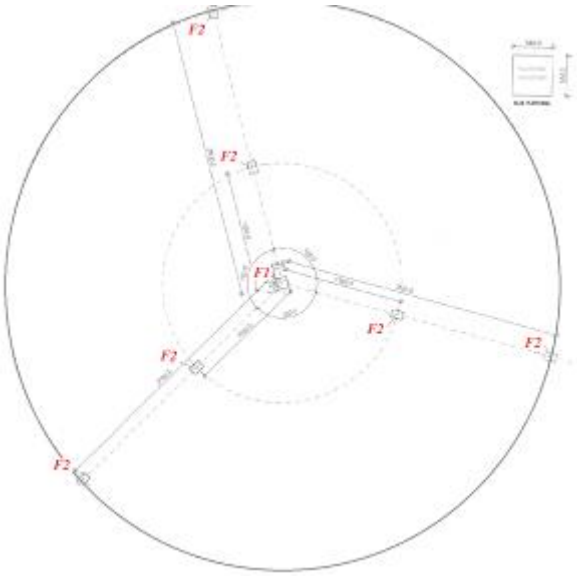

Figure 5 - Pillars F1 and F2 Antenna Radio FM, outside Jebel, Timiş County

To get the building authorisation, besides the land survey acknowledged by the Timiş Land Survey and Real Estate Advertising Office, we will also need:

- A D.T.A.C. technical documenting;
- A decision form the aeronautic authority;
- A decision from the Ministry of Internal Affairs;
- A decision from the telecommunication and optical fibber operators authorities;

- A decision from the Aquatim (water supply and sewage);
- A decision from E.O.N (gas);
- A decision from E.N.E.L. (electricity).

Below is an analysis of data comparison from measurements with GPS equipment and data processing with LIDAR (Figure 6) with the programme ***Global Mapper***. Figure 7 shows information on the set of data of the SRTM type for a resolution of 3 seconds. New data generated with SRTM at 1 arc-seconds or about 30 m achieves a much higher resolution compared to data for a resolution of 3 arc-seconds (i.e. 90 m); unfortunately, these are available only in the USA and outside this country they collected data for only 3 arc-seconds.

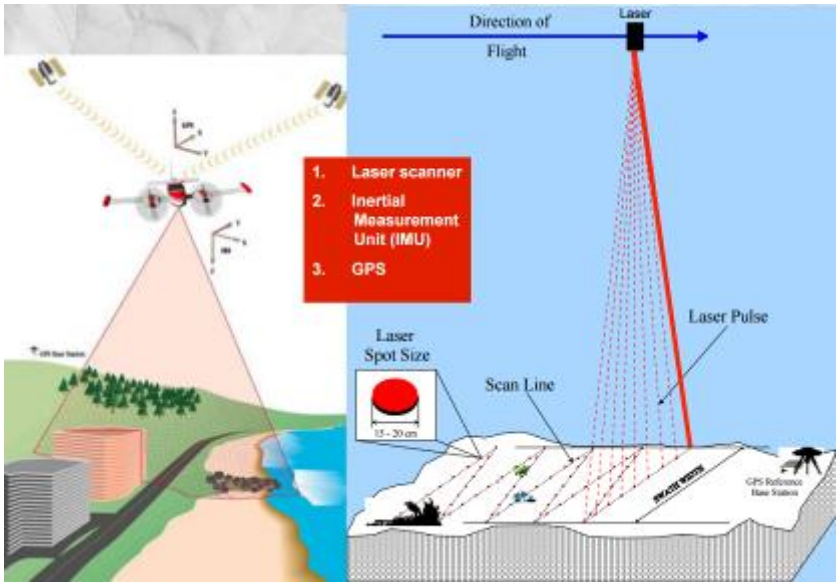

Figure 6 - LIDAR data collection

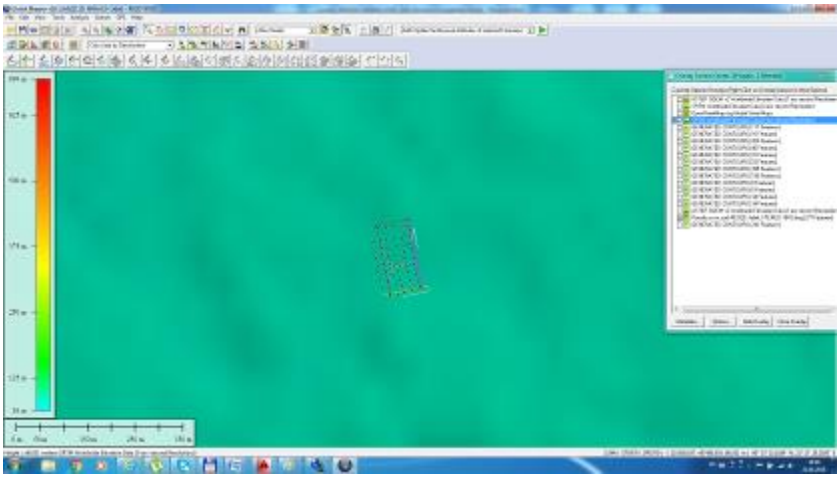

Figure 7 - SRTM World Elevation Data (3 arc-second Resolution) no. 403328

Figure 8 presents level curves obtained with the set of data SRTM World Elevation Data (3 arc-second Resolution) at 1 m equidistance. Based on the SRTM set of data we obtained values closed to the ones determined with GPS equipment, values representing the land quota and ranging between 86 and 87 m. According to GPS, altimetric values ranged between 86.1 and 86.95 m.

Figure 9 presents a set of data ASTER GDEM2 World Elevation Data (1 arc-second Elevation Resolution).

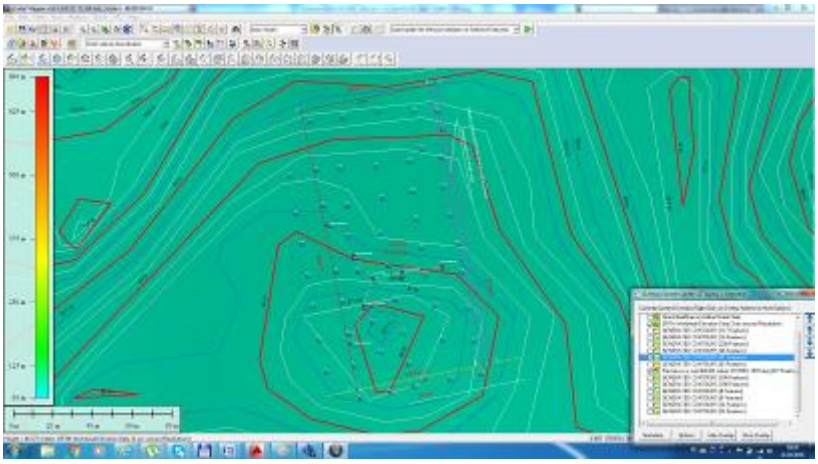

Figure 8 - Level curve for the set of data SRTM World Elevation Data (3 arc-second Resolution) equidistance 0.1 m

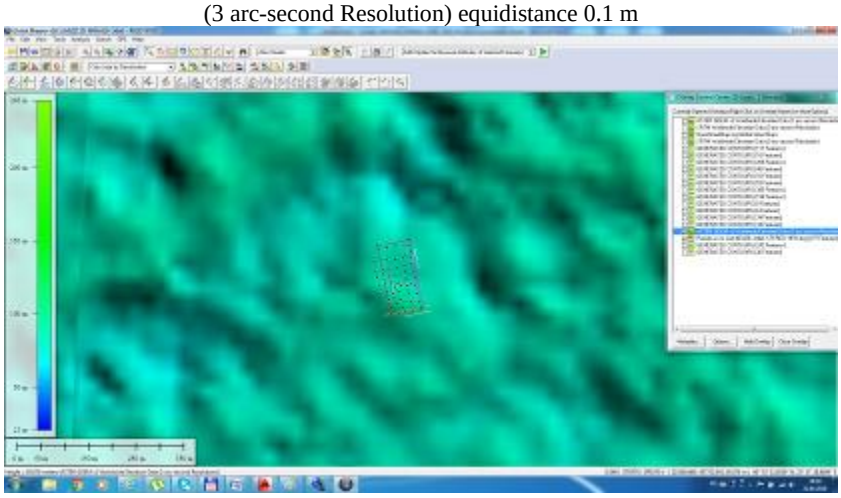

Figure 9 - ASTER GDEM2 World Elevation Data (1 arc-second Elevation Resolution)

Figure 10 presents level curves obtained based on a data set ASTER GDEM2 World Elevation Data (1 arc-second Elevation Resolution) at an equidistance of 1 m; the range of quota values is much wider, ranging between 84 and 88 m.

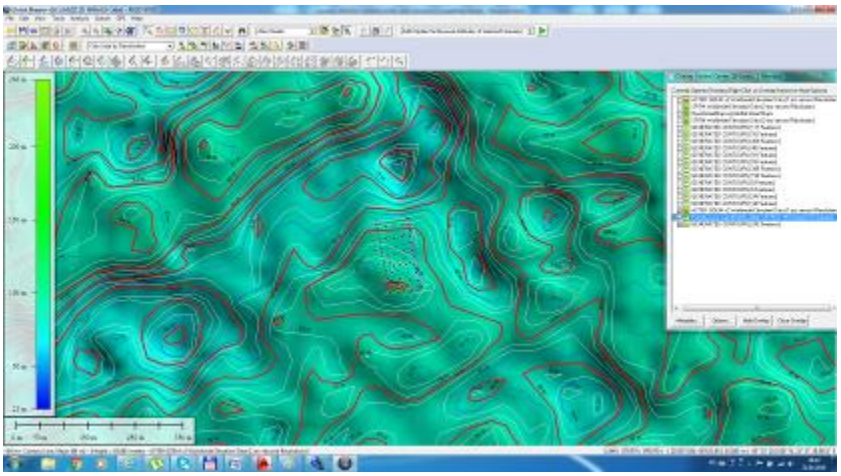

Figure 10 - Level curves for the set of data ASTER GDEM2 World Elevation Data (1 arc-second Elevation Resolution) equidistance of 1 m

CONCLUSIONS

- The opportunity of this work is to cover radio transmission parameters in the area;
- The objective has no source of electromagnetic radiations;
- Taking into account the details mentioned in the constructive regime, the objective does not produce smoke or artificial fog;
- The objective does not attract birds, the precincts is not crossed by air lines, the objective does not need a decision from the water supply office, against noise or vibrations, or for air protection or for protection against radiations;
- The pillar segments will be painted in red and white;
- The building corresponds to 3rd class category of importance (according to the Ordinance no. 100/19.04.2012);
- The foundation will be built on the layer of dusty clay 1,5 m deep in the soil;
- Upon soil excavation, the last layer 0.3 m thick will be removed only before the concrete to avoid either cracks in case of drought or marshing in case of heavy rainfall;
- The filling will be done in well compacted layers of 15 cm;
- This paper has been edited with the STEREOGRAPHIC Projection System 1970 and with the level reference system MAREA NEAGRĂ 1975.

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