TOPOGRAPHIC-CADASTER WORKS FOR THE DESIGN OF AN ECOLOGIC PARKING FOR THE ȘAG-TIMISENI MONASTERY

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Abstract: *The herein work has as objective the performance of the topographic works and the information update for the plot in the administration of Şag-Timişeni Monastery, on the destination, height regime and constructions areas, as well as the registration of the geometry of the related plot, in the integrated system of the cadaster and land registry. Topographic surveys took place in the locality of Şag, Timiş county, having a total area of 36600 sqm. For the measurements performance we used the total station Leica Viva TS06, and for the measurements registration inn the coordinates system Stereographic 1970, respectively Marea Neagră 1975 we used the equipment GPS Leica Viva GS06, in order to determine the station coordinates, an extremely flexible equipment and that contains many applications. In the herein document, in order to determine the station points coordinates it has been used the RTK (Real Time Kinematic) method, using the reference station from Timişoara, that is TIM_2.3. The measurement engine used by Leica Viva is of SmartTrack type that collects satellites in several seconds, being ideal for the areas with obstructions, where other receptors cannot obtain a precise position. The GPS reference system is WGS 84 (World Geodetic System 1984), defined similarly to the ITRF system, by the determined land points coordinates. The processing of measurements obtained on site has been performed using the processing soft Leica Infinity. After handing over the land registry documentation, the beneficiary shall ask from the competent authorities a construction permit for the internal modifications of constructions. Topographic works from this document have been performed in order to update topographic and cadaster information for the arrangement of an ecologic parking for the Sag Monastery, where there have been done also updates on the immobiles identified on site and obtained based on the topographic surveys. Timişeni Monastery is an Orthodox Monastery from Romania located in the Şag locality, Timiş county.*

Keywords: *Leica Viva TS06, Leica Viva GS06, GNSS, Leica Infinity, RTK, WGS 1984*

INTRODUCTION

The appearance of electronic total stations [1,2] represents a huge step in the performance of land measurements by increasing the precision, the working speed and finally the productiveness, considering that in this period we assist to a revolution in this field, starting from the robotic total stations and arriving to the scanning LIDAR systems [3], mobile, fix or of backpack type, installed on vehicles or on tripod, which are capable to fulfill huge performances in order to collect information on site of maximum 1 million points/second.

On the other hand, the appearance and the development of the GNSS [4,5] technology meant the simplification of Topographic surveys performance, and we can clearly say, that in the past, for the determination of the station point, we needed time and visibility to the known geodesic points, but nowadays, both by the RTK (Real Time Kinematic) method or by the static method, it can be obtained information with high precisions.

The use of equipment's using the GNSS technology presents the advantage that there are no necessary angle and distance measurements, eliminating this way the inconvenience of using the total stations, being mentioned also that by the development of the Stop&Go (or Real Time Kinematic) method it is possible to determine the coordinates with a precision comparative to the one assured in the total stations and in a convenient time interval [6]. In parallel with this advantages, it has to be taken into consideration also the necessity that Romania has to fulfill the European and international standards by performing a geodesy network of GNSS reference, of high precision, whose points shall be determined and included in the European EUREF GPS geodesic network.

As from the year 2009, the National Network of Permanent GNSS Stations (RN-SGP) contains a number of 73 permanent stations. The first permanent GNSS station (BUCU) has been installed on 1999 within the Faculty of Geodesy - Technical University of Constructions from Bucharest, with the support of the Cartography Federal Agency (BKG) from Germany. An accentuated development of RN-SGP starts on 2004 by the modernization of already existent stations and by installing new ones. The years 2005-2008 imply a modernization of RN-SGP by the acquisition, by ANCPI of new generation softs and equipment and by their installation. As from the year 2006, besides the permanent GPS station of European category (EUREF), BUCU, that becomes a permanent station in the IGS network (International GNSS Service), Romania participates to the European Network of Reference UEREF-EPN (European Reference Frame – European Permanent Network) by the integration of another four permanent GNS stations: BACA (Bacău), BAIA (Baia Mare), COST (Constanța) and DEVA (Deva). On 2008, on the month of January, there have been installed 48 permanent GNSS stations, arriving, on the month of December, to 58 stations, and until on 2009, to 73 permanent stations. The average distance between GNSS permanent stations is of approximately 70 km.

On 2020, being an year with COVID impact on community [7], on the month of September-October [8], it has been performed an upgrade for the GNSS structure of ROMPOS service, where the National Centre of Cartography took a series of upgrade works of the GNSS upgrade in order to replace and/or install 7 permanent GNSS stations, which are: BAIA, DEVA, SFGH, GHE1, BACA, BAR1 and HAR1, with the mention that, the coordinates shall not suffer significant modifications and antennas shall be installed in the place of the old ones. Once with the performance of this upgrade, equipment using the GNSS technology shall be capable to identify also Galielo signal [9].

Once with the development of the total stations, from the classic to the robotic ones, and with the development of GNSS systems, appeared the laser scanning technology for the topographic field, that can be used as easy as possible in order to obtain amazing results, which in the past have been impossible to obtain. Constructions and plot measurement can be done benefiting of the short period of time in which there can be measured millions of points without being necessary those to be marked on site. The advantage of laser scanning technology is that there is the possibility to measure a construction, in case the access to it is impossible (due to the construction system or if it is affected of certain calamities) in order to perform measurements using the classic methods [10-12].

MATERIAL AND METHOD

Topographic surveys have been performed using the Leica Viva TS06 (figure 1) total station, which is a tachometer with measurement device of distances incorporated. With this electronic device there can be measured horizontal and vertical angles and at the same time, distances.

A total station [13-16] is composed by a theodolite with a measuring device with an incorporated distomat and this way, can measure angles and distances at the same time. Nowadays electronic total stations are the ones provisioned with an optical-electronic device that measures distances (EDM) and with electronic scanning of angles. Coded scales of horizontal and vertical circles are electronically scanned, afterwards the angles and distances are digitally displayed. The horizontal distance, the difference of height and the coordinates, are calculated automatically and there can be registered all supplementary measurements and information.

In comparison to the classic instruments where the data registration is done manually in the field standard booklets, the Total station displays, calculated and registers measurements and coordinates facilitating considerably the user's work.

The complex total station presents multiple possibilities, from the USB port, for the data import and export, and the Bluetooth connectivity, to the cable connection, the station offering complete access to the data collected on site. FlexLine Soft is very easy to operate, and data collection is fast, while the multitude of applications makes the operator to perform, using different operations directly on site.

Fig.1 Leica TS06 Total Station

Fig. 2 Leica Viva GS06

Besides the total station Leica TS06 it has been also used the Leica GS06 equipment (figure 2) with working possibilities in real time with double frequency internal radio. Depending on the satellite systems and on the configured signals, it is assigned a number of maximum 72 channels for GS06.

The precision depends on a series of factors that include: the number of controlled satellites, the constellation geometry, the observation time, the emphemeris precision, the multipath error and the solved ambiguities.

The ROMPOS connection (a system assuring precise positions in the European Frame of Reference and the ETRS89 coordinates) and the control of parameters control points related to the station reading is done with a lot of attention [9-10].

For data processing we have used the following softs:

- Leica Geo Office Combined: for GPS data downloading
- Leica Geo Office Tools: for data downloading from the total station
- Leica Infinity
- AutoCad: for data processing

The working methods adopted for this work are the roading method, supported on ends on the coordinates points and known orientations and the radiation method with the total station.

Roading is represented in the plan as an broken polygon line, where the reciprocal position of points is determined by the measurement of distances between the break points and by the measurement of angles in break points of the polygon route.

Roading supposes the geodesic network thickening in order to determine the detail points coordinates on site. Geodesic network thickening has been done by determining coordinates of some points of V order that shall become the main elements of the topographic survey. For this reason, their determination supposes a very precise measurement.

For the roading design, it has been considered that its route to be chosen depending on the accessible alleys of the ares, the roading points to be fixed in order to allow the visibility between them and towards the radiated points, but also in areas protected by destruction, so that the station device is done easily.

The characteristic points of planimetry points and of levelling have been done by the radiation method, a method used in any situation, where it can be taken a visa and it is possible to measure a distance. The position in the plan of a radiated point (new) is defined depending on the old points from the survey network, by a polar angle or θ orientation and of course, from the distance reduced to the d horizon. Generally, radiated points have been disposed radially around the station and have been controlled successively by going through the horizon tour.

RESULTS AND DISCUSSIONS

Topographic survey has been performed at the Șag-Timișeni Monastery, where it has been stationed on the station point S2 and the device orientation has been done from the station point S1 by the automatic method for the device orienting, points whose coordinates have been obtained using the equipment GNSS Leica GS06.

Control points within the roading, that are the station points S1 and S2, have been surveyed using the GPS.

The start point of roading is representing from the station point S2 located in the ecologic parking of the Monastery, marked on site by a metallic bolt. Orientation has been done from the station point S1 that, afterwards, has been also read. From the station point S2, it has been assigned a visa in the frontal area and has been read the station point S3, and the procedure continued until the roading has been finalized.

Roading has been closed on the station points S3 and S4 and read from the station point S2. Station point S5 has been surveyed with GPS, but due to the creation of the multi-path effect registered a level difference of approximately 1 m and for this reason it hasn't been taken into consideration as a station point in the roading calculation.

For the detail points radiation it has been used the roading method supported on ends, on known orientation and coordinates points, where there have been determined based on the roading the following thickening points of he geodesic network (table 1).

Table 1

Coordinates of radiated points - Șag-Timișeni Monastery in the STEREO'70 coordinates system

No. Point	X [m]	Y [m]	No. Point	X [m]	Y [m]
S2.1	468445.2344	204497.4894	S3.1	468622.0386	204521.1082
S2.2	468454.8743	204498.3386	S3.2	468643.0311	204525.3070
S2.3	468463.5122	204501.4573	S3.3	468649.5271	204524.0297
S2.4	468477.8534	204499.1148	S3.4	468665.1431	204523.1181
S2.5	468478.3832	204501.7272	S3.5	468656.3927	204532.4652
S2.6	468485.0845	204502.5051	S3.6	468652.7041	204533.5956
S2.7	468486.2364	204499.4051	S3.7	468651.1844	204533.8283
S2.8	468499.7348	204500.3412	S3.8	468644.0210	204535.2902
S2.9	468499.7206	204506.6232	S3.9	468636.7927	204539.1977
S2.10	468499.4971	204497.9012	S3.10	468634.3713	204538.4020

The roading method occupies a central position in the assembly of surveys on site by the volume and frequency of works in which it is requested. The main place is held for the determination of the survey network and for details positioning, but it can be used also for the thickening network performance.

After finalizing roading (figure 3) using the total station of fix elements nearby the studied immobile, we have performed a topographic survey in real time using the GNSS system inside the immobile for obtaining the plot heights in the studied area.

	157	157	Measured RTK	204 355.8104	468 705.3343	86.4970	20.3546	30	-	0.0170	0.0101	0.0137	23/06/2020 10:40:22
	158	158	Measured RTK	204 354.4823	468 713.9835	86.3209	20.1784	30	-	0.0208	0.0118	0.0172	23/06/2020 10:40:44
	159	159	Measured RTK	204 351.2776	468 728.8439	86.3439	20.2011	30	-	0.0259	0.0146	0.0214	23/06/2020 10:41:09
	160	160	Measured RTK	204 347.8463	468 745.5765	86.2708	20.1278	30	-	0.0256	0.0156	0.0204	23/06/2020 10:41:41
GS	161	161	Measured RTK	204 384.6916	468 674.0513	85.6766	19.5351	28	-	0.0243	0.0146	0.0195	23/06/2020 10:44:46
	162	162	Measured RTK	204 416.3819	468 663.4634	85.9025	19.7615	28	-	0.0365	0.0182	0.0316	23/06/2020 10:45:22
	163	163	Measured RTK	204 450.8301	468 651.9072	85.9426	19.8022	28	-	0.0309	0.0156	0.0267	23/06/2020 10:46:01
	164	164	Measured RTK	204 479.8023	468 641.9475	86.2366	20.0967	28	-	0.0217	0.0112	0.0186	23/06/2020 10:46:37
	165	OR1	TPS Measured Reflector	204 502.3461	468 515.6307	87.1976	21.0598	01	-	-	-	-	23/06/2020 10:07:36
	166	RTCM-Ref 0000	GNSS Setup	207 132.2622	482 495.1213	111.6266	45.3267		-	-	-	-	23/06/2020 09:41:49
	167	S1	Control	204 502.3390	468 515.5690	87.1920	21.0542		-	-	-	-	23/06/2020 10:07:11
	168	S2	TPS Setup	204 508.7510	468 567.0040	86.7430	20.6046		-	-	-	-	23/06/2020 10:07:12
TPS	169	S2.1	TPS Measured Reflector	204 497.4894	468 445.2344	87.3786	21.2417	26	-	-	-	-	23/06/2020 10:10:57
	170	S2.2	TPS Measured Reflector	204 498.3386	468 454.8743	87.4011	21.2641	04	-	-	-	-	23/06/2020 10:11:14
	171	S2.3	TPS Measured Reflector	204 501.4573	468 463.5122	87.4038	21.2667	04	-	-	-	-	23/06/2020 10:11:54
	172	S2.4	TPS Measured Reflector	204 499.1148	468 477.8534	87.4447	21.3073	04	-	-	-	-	23/06/2020 10:12:11
	173	S2.5	TPS Measured Reflector	204 501.7272	468 478.3832	87.4394	21.3021	04	-	-	-	-	23/06/2020 10:12:23

Master Coordinate System

Coordinate System Name:	E-TransDatRO
Transformation Type:	Classical 3D
Residual Distribution:	None
Ellipsoid:	Krassowski
Projection Type:	Customised
Geoid Model:	EGG97&MN75
CSCS Model:	csRomania

Fig. 3 GS + TPS coordinates file

Based on the performance of topographic measurements on site, it has been proceeded to the data processing and to the performance of layout plans (figure 4, 5, 6).

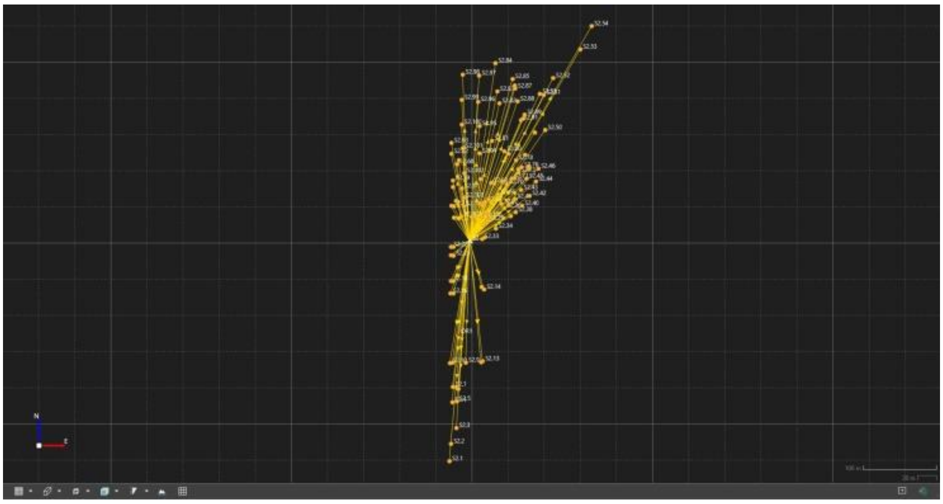

Fig. 4 Radiated points from the total station

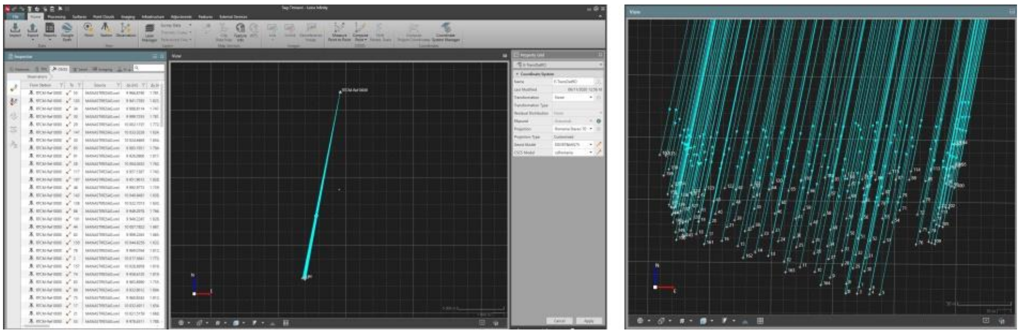

Fig. 5 RTK determined points using the permanent station Timisoara

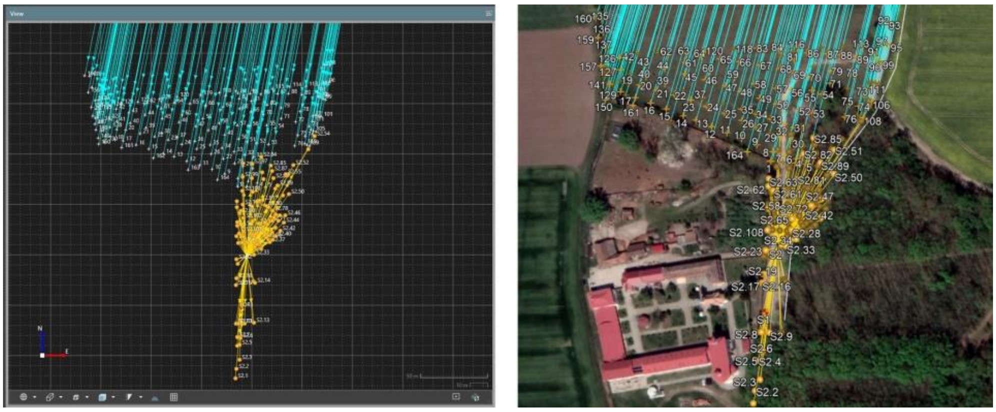

Fig. 6 Points combination from the total station with those from the GPS

For the measurements control, processing result has been overlapped to the ortophotoplan corresponding to that area (figure 7).

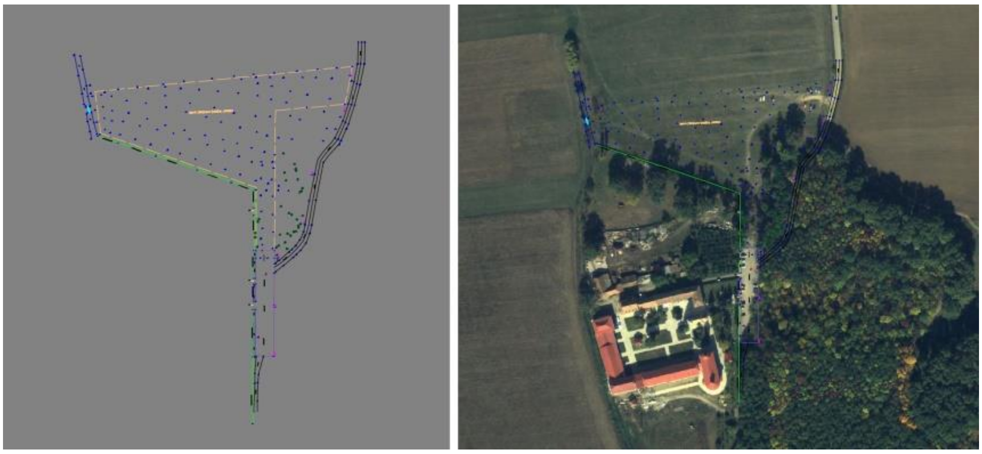

Fig. 7 Data processing in AutoCAD

After finalizing the topographic measurements it has been drawn up a layout plan, as well as a topographic plan (figure 8).

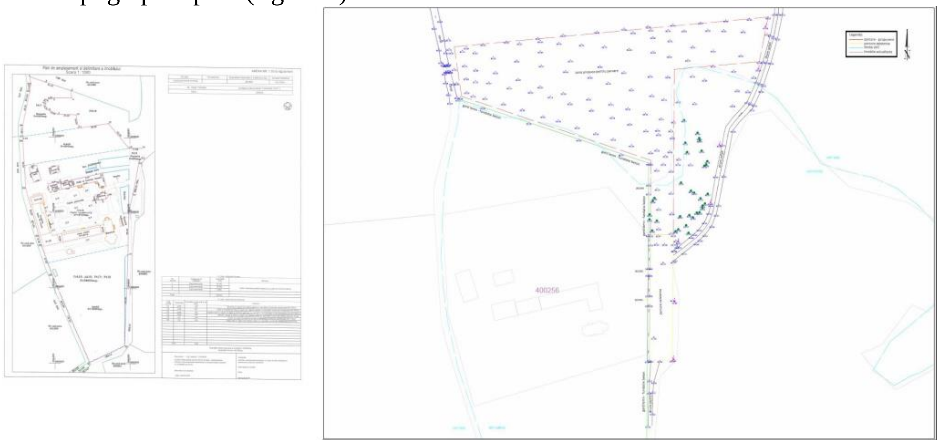

Fig. 8 Layout plan and topographic plan

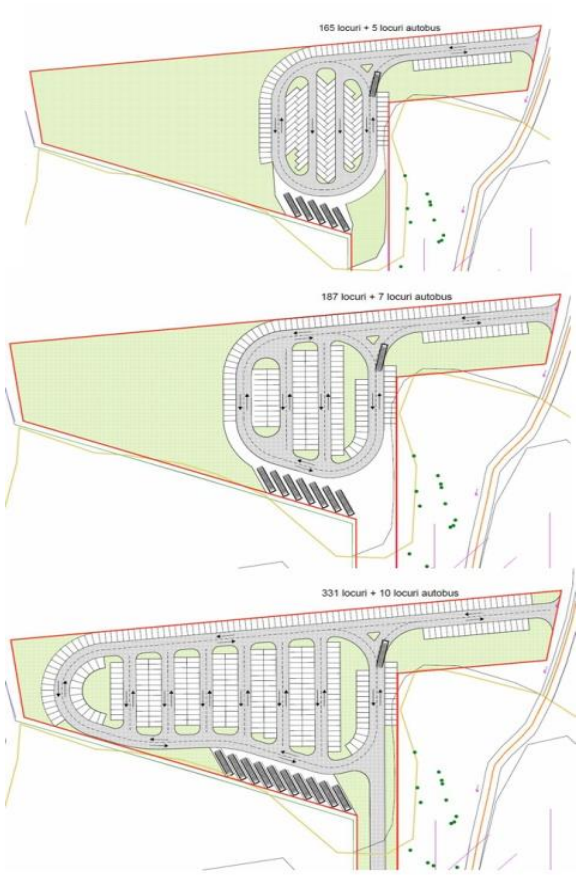

Fig. 9 Proposals for the parking arrangement

Due to the fact that all data introduced in the 2D plan are from a coordinates system, it can be used also in the design and arrangement activity [5]. The proposed arrangement example can be delimited and materialized in the future. Depending on the beneficiary's requirements, we have performed three parking arrangement proposals, one for 165 parking places + 5 places for the bus, the second variant includes 187 parking places + 7 places for the bus and the last proposal has been drawn up for 331 parking places + 10 autobus places (figure 9).

CONCLUSIONS

Topographic works from this document have been performed in order to update topographic and cadaster information for the arrangement of an ecologic parking for the Sag Monastery, where there have been done also updates on the immobiles identified on site and obtained based on the topographic surveys.

Timişeni Monastery is an Orthodox Monastery from Romania located in the Șag locality, Timiş county, being a monastery of nuns, with the patron saint „Tăierea Capului Sfântului Ioan Botezătorul", located at approximately 14 km from Timișoara [15].

The total station, by the offered possibilities and structure, became the representative instrument, used today in exclusivity for the roadings measurements, being, at the same time, the only serious competitor of the GPS system.

Total station is an optical instrument used for the topographic measurements. More precisely, it is a combination between the classical theodolite and an electronic instrument for distances measurement. With the main total station there are measured the vertical and horizontal angles, depending on the real North, as well as distances from the measured point.

Total stations Laica are equipped with a software package that allows the fulfillment of the majority of topographic charges more easily, faster and more elegantly.

The GNSS positioning system has been used in order to determine the coordinates of control points (roading heads) within the topographic surveys.

GNSS technology uses signals sent by satellites which have the paths so that any point from the plot area can be determined within 24 hours, independently of the meteorological conditions. The positioning precision depends on the GPS receiver type and on the observation techniques and post-processing used.

In comparison to the use of a total station, GPS technology offers the advantage that the points which shall be measured don't have to be visible reciprocally.

Information collected in this manner from the total station have been downloaded using the Leica Geo Office Combined software and compensated by the TopoSys software. TopoSys calculates and compensates any combinations of distances and angles measurements in order to determine a more precise correction of measured points coordinates. The processing method of coordinates allows the obtainment of a precision of centimeters. Using this software it has been created a DXF file uploaded ulteriorly in AutoCAD.

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