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TOPOGRAPHYCAL METHODS IN CIVIL ENGINEERING

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Abstract

The methods, the techniques and the advanced instruments used in engineering field and the land surveying made possible the applicability in many engineering fields. It provides the ability to save time and resources while due to the precision offered by the instruments and the working methods can achieve sustainability studies, extent and hostile land for construction industry; the size of the construction components, precision topographic works to designing and building the edifice, the nature and volume of oscillation of level earth, the nature of the materials used, methods of execution deadlines for putting into use, etc. Application of topography can not be a passively act, but an active one, both in design and the execution of engineering objectives.

Key words: *effectiveness, methods, precision, topography.*

INTRODUCTION

In Civil Engineering works, topography, precedes and accompanies any study, phase and finishes the construction process. Benefits of topography applicability in construction works lead to a better development of the construction by shortening the term of design and building works, but also to a better organization of the workplace.

The domain of topographical engineering has had a remarkable development in terms of technical sciences in the last decades. Thus allowed to expand the area of application of topographical engineering in other activity fields than to draw up plans and maps necessary for the design of construction works.

The participation of the topographical engineering in design and management has increased significantly since the current stage of the industrialization of the construction process of surveying engineering works, tend to integrate in the construction and assembly work on construction sites.

As the mechanization of construction and use techniques with modern technologies has increased, topography plays a significant role in the design and execution of construction, since the methods and the topographical tools make available plans and topographic profiles updated on large scales without which the design, implementation and execution of the construction field can not be achieved. Furthermore, in the process of construction exploitation, starting with the reception of the project and finishing with the last observations and building inspection to ensure compliance with building regulations, requires geodetic surveying.

Land surveying engineeringis a branch of geodesy studying and solves a number of problems related to studies of engineering, design, construction and operation of buildings of any kind, including investments in transport, agriculture and machinery industry as well as land planning on towns and villages.

Engineering uses topography measuring instruments and methods of surveying and geodetic calculation used in the development of the state geodetic and cartographic data.

For solving construction-assembly verification on higher buildings of special shapes, comments on the strains and movement building, get in to use instruments with high accuracy.

MATERIALS AND METHODS

The network of the building is presented as a network of squares or rectangles compact the sides 100, 200 or 400 m, having the coordinates calculated in a particular system of axes parallel to the axes of the drawn construction (Figure. 1). Squares and rectangles network peaks are marked by concrete terminals, while being leveling and landmarks.

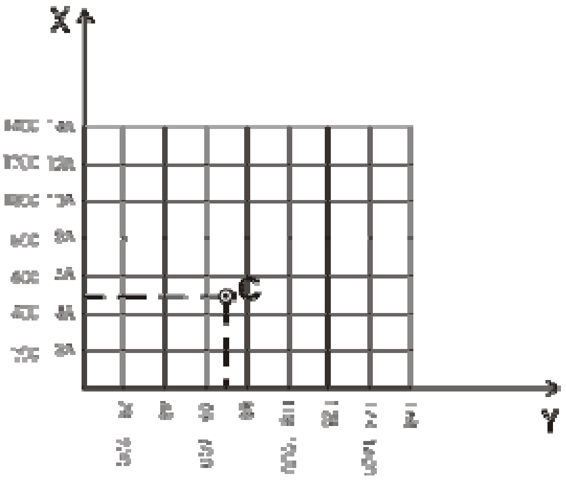

Figure 1. Coordinates Network construction.

Building network design is usually carried out on the overall design of the projection lens and consists of the locations network and finding the coordinates peaks network (coordinated design), compensation network and network final drawing.

The network design of the construction it must take consider the following criteria:

- network sides are parallel to the axis buildings so that the buildings to get fit into the rectangles or squares;
- building network points must be out of the excavation area, and the contour lines as close to the traced object;
- building network points enable linear and angular measurements;
- the network must have mostly an economical shape, which reduce or increase the density of points depending on tracing requirements;

Squares or rectangles grid coordinates are calculated from the general system of coordinates with translation. Basically calculate the coordinates of at least three points located in each alignment. After checking the points colinearity we calculate the coordinates of points, knowing the distance between points located on the same segment.

Given that all construction details are given by their axes, the construction slope will consist of:

- drawing axes to trace network points;
- drawing in detail about the axes materialized on the ground.

For the design and execution it will take in consider major axes, basic axes and intermediate axes.

The main axes are constituted by two perpendicular straight lines I-I and II-II arranged symmetrically in relation with the construction (Figure 2). The intersection point between two axes induce the coordinates in the given system. As a rule, the axles are applicable to the field for constructions that have a large area and a complex configuration (Mihail, 1966).

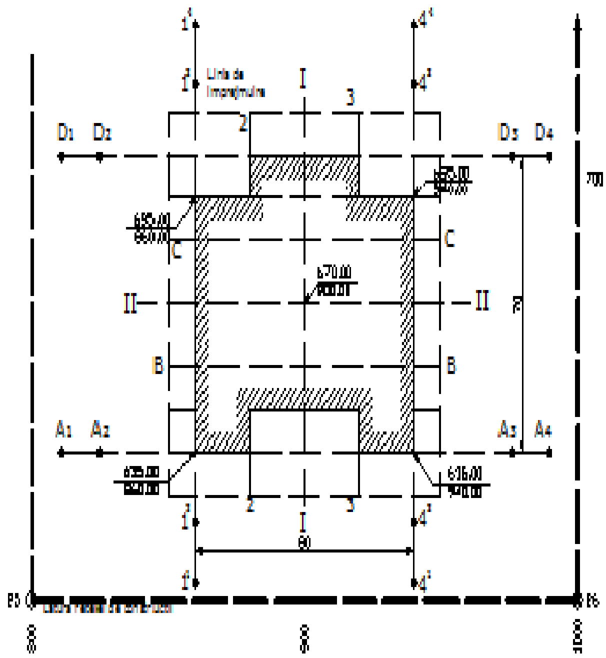

Figure 2. The tracing plan axes.

The basic axes are axes that forms the outline of the building. In practice, plotting construction apply on land just these axes passing through the main minutiae by Cartesian coordinates of the network construction. The other axis is called intermediate axes (secondary).
Materialization of the axes, is evidenced by at least twomaterialized landmarkson both sides of the building.
Axes basic plot points they are laying out on the ground points to the network construction by the rectangular coordinates method.
Checking the laying out construction points it's made by way of:

- laying-out these points by another method;
- lay-out the points on the other side of the network construction, using the same method;
- by comparing the measured distance between marked points, with the one given by the project;

Currently, when most businesses and surveying companies have total stations such as: Leica, Trimble, Topcon, etc, project implementation on the ground is made with high accuracy and at an optimal time (Figure 3).
Because Leica brand is placed on top three brands in the world, I will present the workstation program.
Setting out-calculate the necessary elements plotting of manually entering coordinates or angles, horizontal distanc and height of level, differences between the stationary point sought and can be displayed continuously.
Setting out coordinates from the following stages:

- Select the point:
- [DIST]: starts measuring and calculates the elements outlined.
- [REC]: saves readings.
- [Dir&Dis]:introduce trace elements.
- [MANUAL]: working towards introducing simplified point for ID and without storing it.

Orthogonal Setout:
You can enter differences coordinated out point to be mapped to the reference line. The program calculates the difference between the calculated and measured point. The program displays the orthogonal (ΔLine, ΔOffset, ▲◢▌) and polar (ΔHz, ▲◢, ▲◢▌).
Stages of work:
1.We introduce orthogonal stake out elements or searching point in the internal memory.
2. [SET] confirm the calculation and data entry.

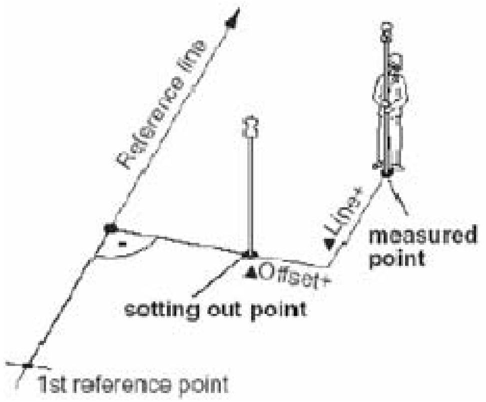

Figure 3. Laying-out orthogonal points.

1. setting out point (Figure 4).
2. measured point (Figure 5).

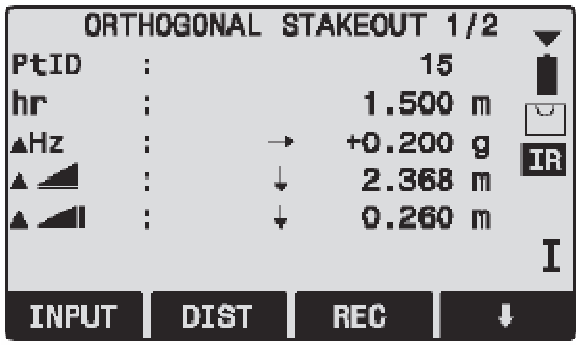

Figure 4. Settings screen for points orthogonal to the reference line.

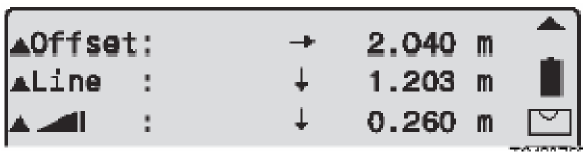

Figure 5. Lay-out corrections for a point to another field point by the measured position.

The sign for the angle and distance differences is exactly like the one on app "Setout"
Corrections values are presented as:

- +▲Hz : Turn the telescope clockwise to the stake point.

- : Out point is farther away than the measured point.
- : Out point is above the measuring point.

For designing and drawing bridges and viaducts we need primarily concerned basin lock plan, which can be obtained by copying from existing maps at scales of 1: 100,000, 1: 50,000,such as its size do not exceed 40x20cm time scale and which is the necessary basis for drawing up the situation plan and the necessary plan of the bridge on large-scale design in detail.

The situation plan: is drown on scale of 1:5000 for small rivers and on 1:10000 for those with a large width, usually using aerophotogrammetrical method, tachimetrical method for the zones with small stretching or fototheodolite for tough zones.

The large scale plan: laying out on a scale of 1:1000 with the equidistance of level curves E=0,5 m for a crossing lenght <300 m and fot the scale 1:2000 with E=1m for longer lengths are used for drawing in detail of the bridge and for the detail studies of the access roads.

Network support for designing bridges and plotting their heads is achieved by the planimetric traversing and elevation on both sides (Figure. 6), related to the geodetic network.

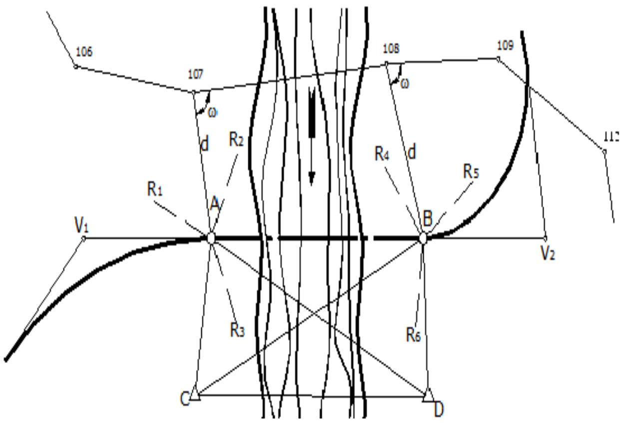

Figure 6. Reconstitution of a bridge axis.

The ends of the bridge by data points M and N are placed each on one shore areas from flooding (Figure. 7).

When is not known the position of the two points in the land, previously designed the plan situation, will be performed either by locating their plotting against surrounding objects existing in land and on the situation plan either by drawing angular peaks (V1.2; V1,3) axes access roads to the bridge.

The length of the bridge can be determined by the following methods: a tachometric, geometric, by direct measurement by measuring parallactic, trigonometric.

Tachometric method - consists of measuring the length of the axis of the bridge after previously were determined tachometric divisions bribery and constants.

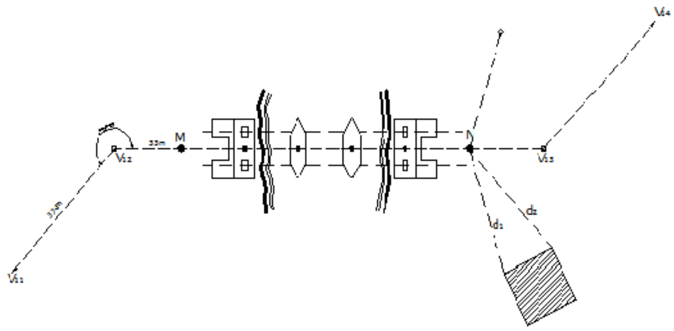

Figure 7. Drawing bridge access roads to the area.

Geometric Method, is used when we have materialized on the ground the ends of the bridge, without them being related to geodetic coordinate system (Figure 8).

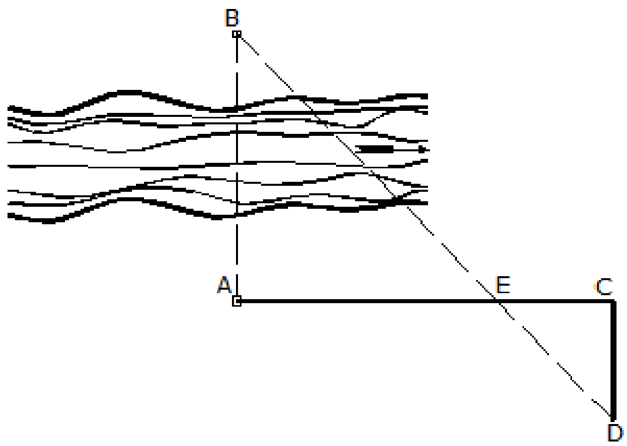

Figure 8. Determining the length of the bridge with the geometrical method.

It will be build on one of two sides at right angles at points A and C with a topographical square.

Likeness of right triangles that form we can write:

$$AB = CD\frac{AE}{EC}$$

All the elements will be measured in the horizontal values using the roulette.

Direct measurement method:

It can be applied in the following three assumptions:

a) When passing the bridge over the valley it is dry;

b) The floor built on rivers with water depth <3m;

c) In winter season when ice is formed.

When measuring over the dry valley or in winter season, (a and c) will be used invar wires or ribbons with millimeter divisions beeing necessary:

- to cleanse the land bridge axis direction, to enable direct measurement instrument settlement;
- to apply corrections to reduce the horizon, to align more closely the ribbon alignment and use dynamometer;

For the measurement of the distance across rivers with water depth up to 3 m,it can be build a scaffold of pilots beaten at intervals of 3 ... 4 m which are secured by cabinet on top.(Figure 9).Pilots will be mounted on a horizontal floor at the top and another at the bottom that moves the operator.

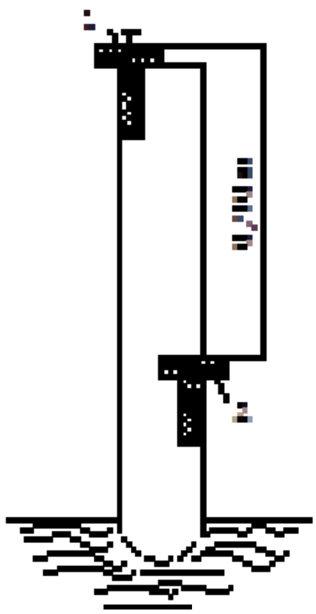

Figure 9. Scaffolding for the measurement of length.

Trigonometric method of determining the length of crossing obstacles, It is based on the determination of horizontal base on both sides of the river or only a part of it and precisely determining all the angles that are formed between the axis of the bridge.

Schemes for the bridge length about trigonometric calculation are:

a) Determining the CD length of the bridge from two bases, situated on a river side, accurately measuring all the angles that are formed by applying sine theorem (Figure 10).

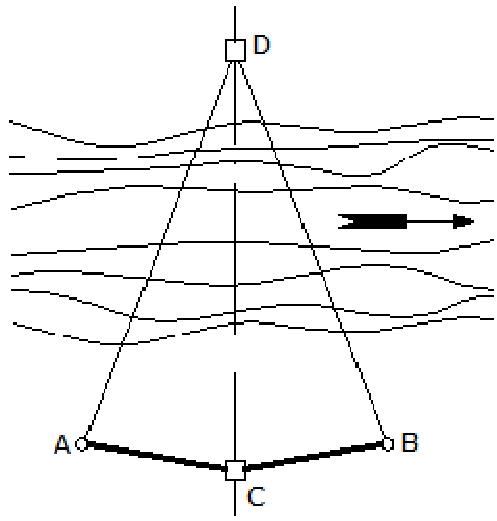

Figure 10. Trigonometric determination of the length of the bridge by using the adjacent triangles.

If the deviation between the two values obtained for length CD are insignificant then we will use their arithmetic mean.

b) Determining the CD length of the bridge from two bases on either side of the bridge. Depending on the obstacles on the ground, for placement on the basis of the same side of the bridge axis (Figure. 11) or opposite to the two ends (Figure 12) with lengths of 0.7 to 1 from C-D length .

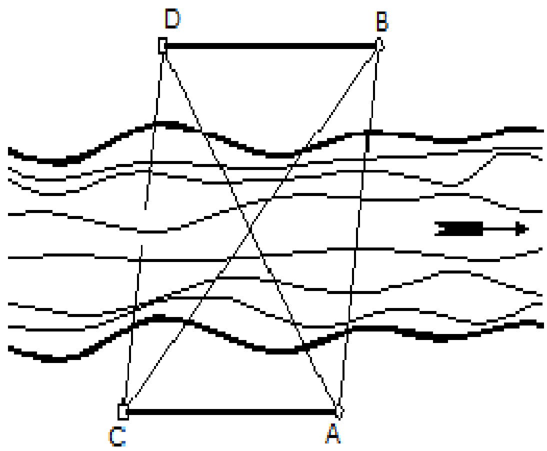

Figure 11. For placement on the basis of the same side of the bridge axis.

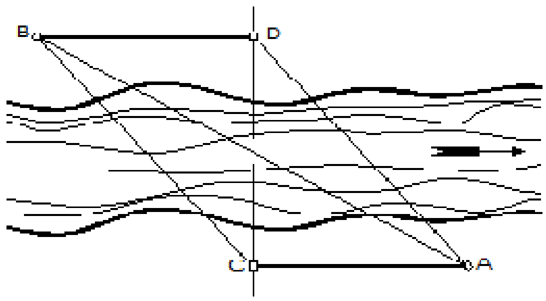

Figure 12. For placement opposite to the two ends.

It will measure and compensate all angles in a triangle, then we calculate applying the sine condition for more independent values of each triangle.

c) Determination of the length axis of the bridge (CD) with two equal and non-perpendicular and symmetrical to the axis CD of the bridge.

Applying this method will increase the accuracy of determining axis, because we have a double number of standing tops, compared to the previous method (Figure 13), and accuracy of calculation will be about 1 : 5000.

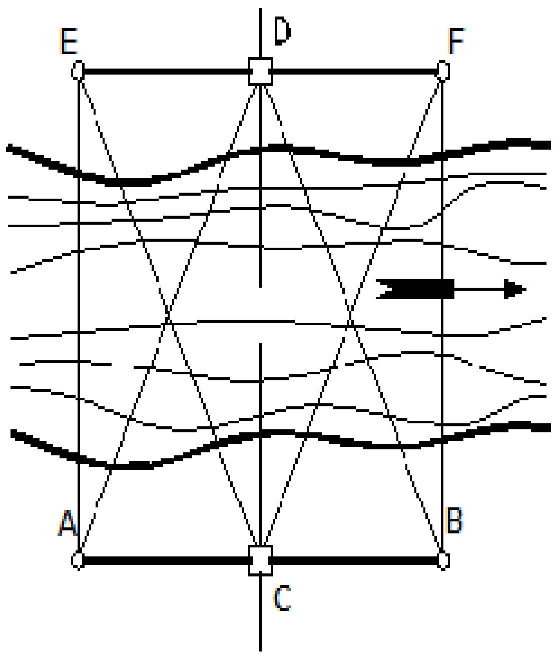

Figure 13. Determining the length of the bridge, using the adjoining quadrangles.

As a general rule all three schemes, it should be noted that the points C and D representing the ends of the bridge must be well marked planimetric related and altimetry network support of the site (Coșarcă, 2003; Onose 2004).

RESULTS AND DISCUSSIONS

As a result, following the measurements on the ground and the data obtained, the construction plan is drawn up, both in 2D and 3D. This helps to track construction,calculation of required material and checks in a relatively short and to the point.

Data processing softwer use various sites, being purchased from the manufacturer of the instrument used (ex. Leica Geo Office, TopoSys, etc.) or beeing the most common softwer office computing package, Microsoft Excel (Figures 14 and 15).

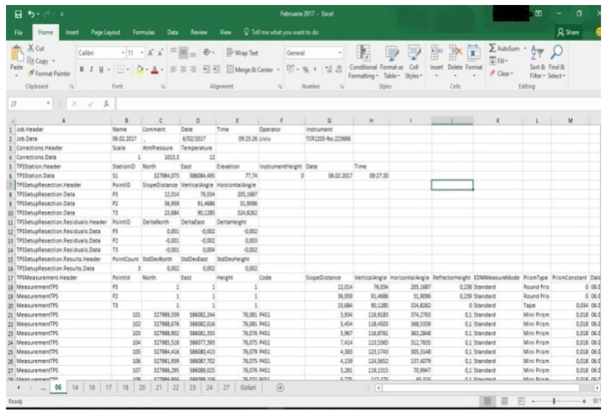

Figure 14. Data Station

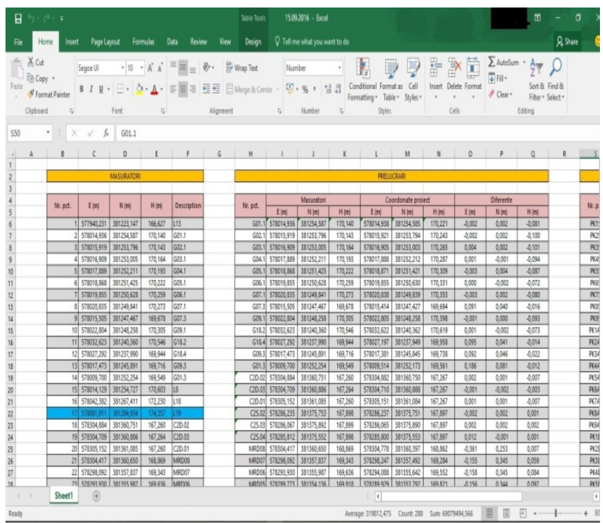

Figure 15. Data Results

Geodetic support network design is a complex operation, the project must anticipate and properly coordinate with other stages of realization of support networks:

- materialization networks, execution and processing of observations.

Drafting the construction of a geodetic network is dependent on the nature, purpose and characteristics considered significant structural geodetic network. In our country, state geodetic networks (respectively triangulation and leveling) are made in a in a suitable density for the majority of the work topographic - photogrammetry, cartography and cadastral.

Establishment of the draft triangulation is to establish a map at a certain scale, the position of geodetic points so that geometrical formats satisfies the conditions of that triangulation order.

Points position will be chosen to occupy a dominant positions in field,to ensure visibility between them by means of the lowest possible construction and to achieve a conformation as rigorously geometric figures.

For the design of any network triangulation, It takes place at the beginning a documentation which is used to gather information, data and materials design such as:

- preparing the draft is necessary to perform a preliminary reconnaissance of the area in order to gat;
- maps edited at any scale;
- (triangulation, poligonometrie, leveling bases and astronomical determinations), reports on these works, scheme, catalogs coordinate existing brands and descriptions of landmarks leveling, sketches, data and information on existing points, books comments;
- informative data on physicogeographic region working as: relief, river, woods, weather data, (wettest months, the average amount of water per m2, annual state and intensity of the winds, fog, temperatures are recorded during the year);
- economic data: settlements, employment opportunities labor and means of transport, network communication means, network communication ways;
- opportunities to supply food, construction materials, accommodation;
- before further information and confirmation of existing ones (Ursea, 1974).

The design is realized in the triangulation order, starting with the first order and with special care as the lower order to achieve strong links to higher order.I and II orders are projected on maps at 1:200,000, and orders III and IV on maps at 1:100,000.

After designing triangulation network, an analysis is made to show :

- maximum and minimum length of the sides, in order triangulation;
- minimum angles of figures formed on orders the weight value;

Compensate the geodetic networks using the method of indirect observations, known as compensation of the group of points, because it was very much used to hire a number of new points into an older network of a certain order.The documentation will be using both maps and plans, and recentphotogrammetric materials relating to the area. Also are needed data on the geodetic networks previously performed in the region, information on relief, climate, hydrology, ground stability and the existence of coordinated older catalogs: X, Y, H (Cristescu, 1978).

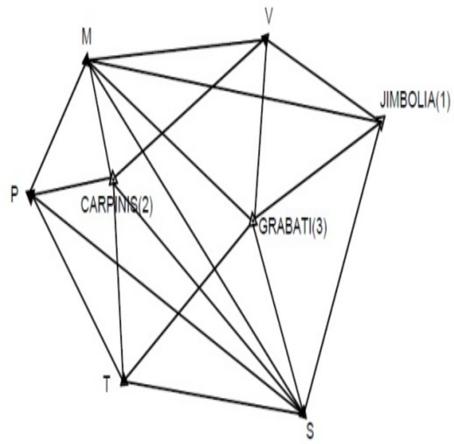

Figure 16. Sketch triangulation network

Calculating distances between old points.

$$tg\theta = \frac{\Delta X}{\Delta Y}$$

$$D^2 = \Delta X^2 + \Delta Y^2$$

Calculating the provisional coordinates for the new set points.

It makes through the intersection before, considering two combinations for each new point. We consider the average values thereof.

$$X = \frac{Y_1 - Y_2 + X_2 tg\theta_2 - X_1 tg\theta_1}{tg\theta_2 - tg\theta_1}$$

$$Y = Y_1 + tg\theta_1(X - X_1)$$
$$Y = Y_2 + tg\theta_2(X - X_2)$$

Or,

$$Y = \frac{X_1 - X_2 + Y_2 ctg\theta_2 - Y_1 ctg\theta_1}{ctg\theta_2 - cyg\theta_1}$$

$$X = X_1 + ctg\theta_1(Y - Y_1)$$
$$X = X_2 + ctg\theta_2(Y - Y_2)$$

(Trigonometric functions will choose that which is smaller in absolute value).
Calculating the provisional coordinates and the directions coefficients.

$$a_{ij} = -\rho^{cc}\frac{\Delta y_{ij}^0}{(D_{ij}^0)^2} = -\rho^{cc}\frac{\sin\theta_{ij}^0}{D_{ij}^0}$$

$$b_{ij} = \rho^{cc}\frac{\Delta x_{ij}^0}{(D_{ij}^0)^2} = \rho^{cc}\frac{\cos\theta_{ij}^0}{D_{ij}^0}$$

Note: For practical reasons, the state triangulation usually consider variation on decimeter and D, Δx and Δy they are expressed in kilometers.
Consumables are formulas (for centesimal graduation):

$$a_{ij} = -\rho^{cc}\frac{(Dy_{ij}^0)_{km}}{(D_{km}^0)^2}$$

$$b_{ij} = \rho^{cc}\frac{(Dx_{ij}^0)_{km}}{(D_{km}^0)^2}$$

In this situation, dx and dy corrections resulting from the clearing will be also expressed in dm (Onose, 2004).
After obtaining the necessary data, they are imported into CAD softwares sites (ex. Autodesk, ArcGIS, etc.). Following import point cloud in the programs mentioned above, joins each point with the index thus forming the construction plan (Figure 17).

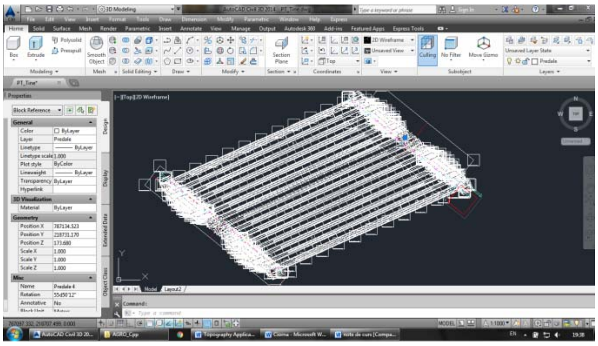

Figure 17. 2D Bridge construction plan.

Achieving 3D plan quickly calculate the volume of each piece of material of construction, concrete volume, the volume of reinforced concrete, shuttering boards and more (Figure 18-28).

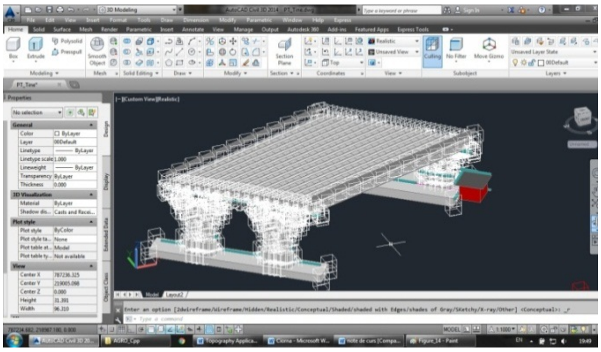

Figure 18. 3D Bridge construction plan.

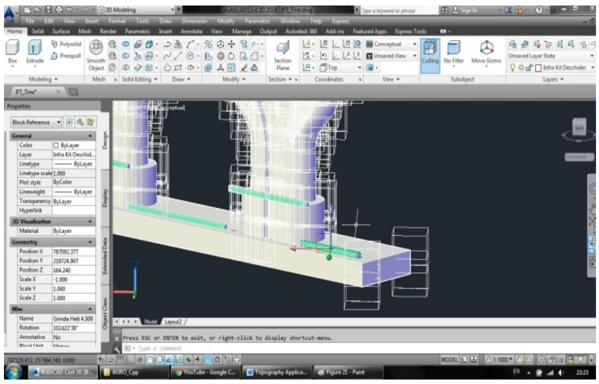

Figure 19. Infrakit Bridge Construction.

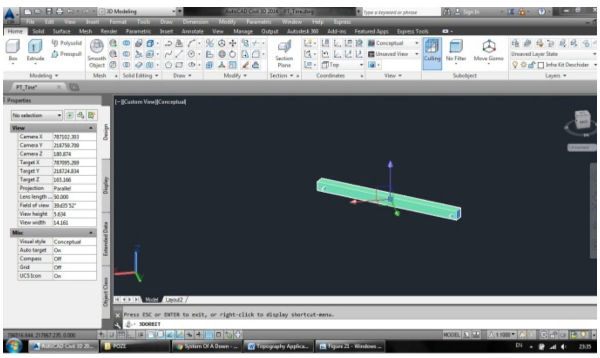

Figure 20. Infrakit Coordinates.

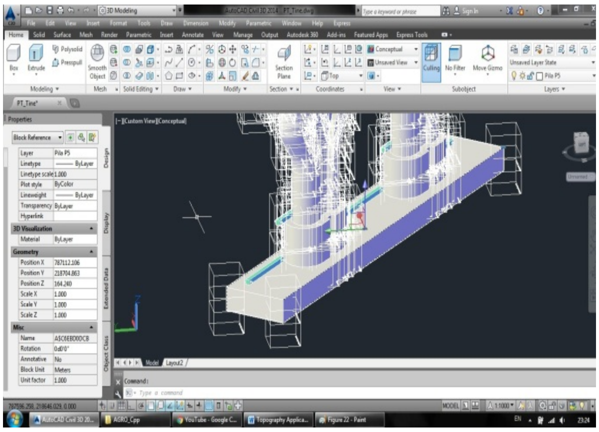

Figure 21. Bridge Foundation.

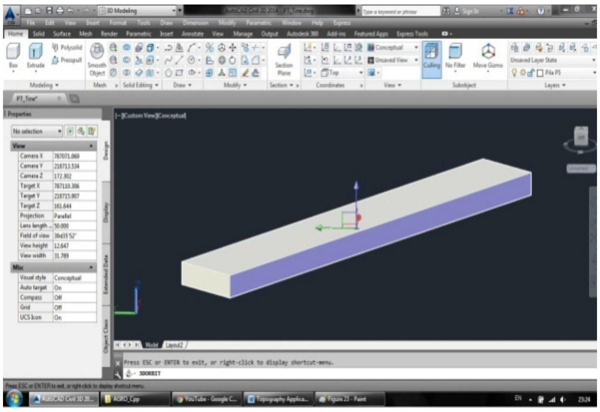

Figure 22. Bridge Foudation Coordinates.

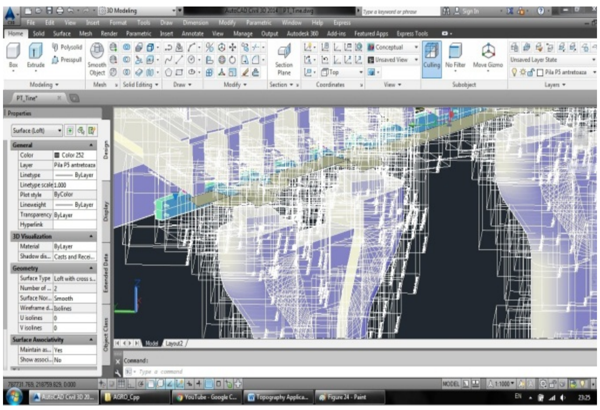

Figure 23. Threaded pin.

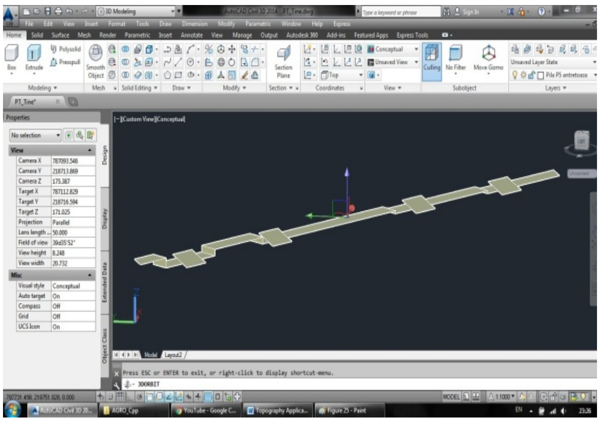

Figure 24.Threaded pin coordinates.

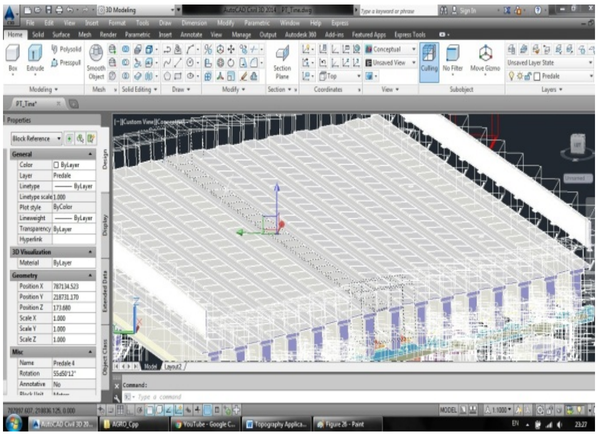

Figure 25. Floor plates.

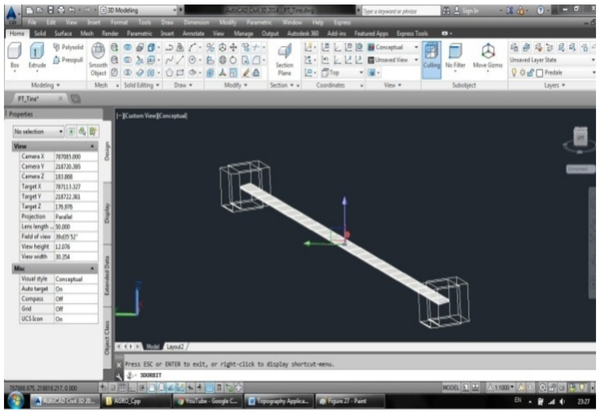

Figure 26. Floor plates coordinates.

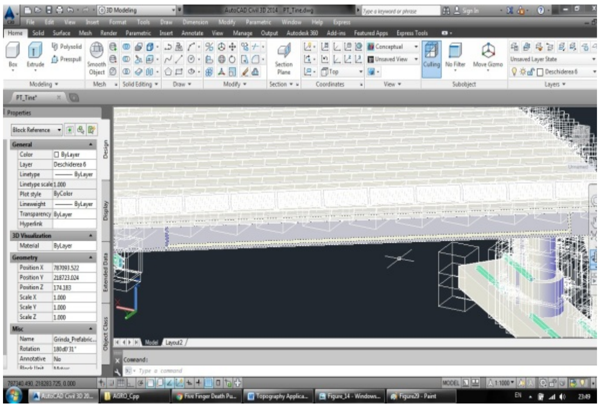

Figure 27. Support beam.

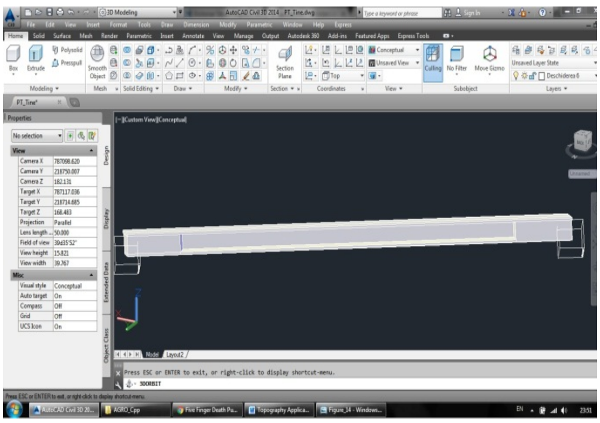

Figure 28. Support beam coordinates.

CONCLUSIONS

The topography has greatly advanced as one of the essential elements of any construction related activities. With the latest technology and methods of calculation, topography engineering reached to be irreplaceable on any type of construction sites. From determining and mapping foundations to completion of construction, topography is not missing from any phase of construction.

By making 2D and 3D digital models of the construction of accurate cartographic terms, they eliminated a lot of fundamental problems winning time on the works. It is important to have a software that will help you to reprocess all the data gathered from the field. Also you have to be very organized regarding data collected from all sources because the software will work with that data and if something is wrong there everything will be wrong when you start reprocess them. Anyway, the softwares are also developed to warn you if something is wrong so you don't go further with wrong data and this saves a lot of time. Working with softwares is more efficient, more precisely and helps you from wasting time.

REFERENCES

Cristescu N., 1978. Topografie inginerească, Editura didactică şi pedagogică, Bucureşti

Coşarcă C., 2003. Topografie inginerească, Bucureşti, Editura MatrixRom

Mihail D., 1966. Topografie, Editura didactică şi pedagogică, Bucureşti.

Onose D., 2004. Topografie, Editura MatrixRom, Bucureşti.

Ursea V., 1974. Topografie aplicată în construcţii, Editura didactică şi pedagogică, Bucureşti