METRIC PROBLEMS FOR DETERMINING DISTANCES: DESCRIPTIVE GEOMETRY VS. AUTOCAD

PROBLEME METRICE PRIVITOARE LA DETERMINAREA DISTANŢELOR: GEOMETRIA DESCRIPTIVĂ VS. AUTOCAD

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Abstract. *In this paper the authors present a comparative study on how to determine distances using the classic variant (Descriptive Geometry) but also the modern one, using the AutoCAD software, presenting for each mode the steps necessary to determine the respective distances but also the advantages and disadvantages of each way of working.*
Key words: Descriptive Geometry, AutoCAD, lengths, distances

Rezumat. *În această lucrare autorii prezintă un studiu comparativ privitor la modurile de determinare a unor distanţe utilizând varianta clasică (Geometria Descriptivă) dar şi cea modernă, utilizând programul AutoCAD, prezentând pentru fiecare mod paşii necesari determinării distanţelor respective dar şi avantajele şi dezavantajele fiecărui mod de lucru.*
Cuvinte cheie: Geometrie Dessriptivă, AutoCAD, lungimi, distanţe

INTRODUCTION

In design engineering activities, there is often a need to determine the size of distances, angles or plane contours.The speciality books present the steps of determining these dimensions using the Descriptive Geometry Methods.

Taking into account the fact that AutoCAD is a program that allows the realization of 2D, 2.5D and 3D representations but also contains a series of commands that offer the possibility to determine the sizes of distances, angles and surfaces, the authors made a comparative study regarding the ways of work listed above for different situations, in which is necessary to determine some distances, analyzing the advantages, disadvantages and difficulties involved each of two work methods.

MATERIAL AND METHOD

In the specialized literature are presented multiple theoretical cases of obtaining distances using Descriptive Geometry (Tănăsescu, 1965; Prună *et al.*, 2006), obviously, in all situations the representations being made in the draught (two-dimensional plane representations). Thus, are presented a series of situations that allow the determination of the following distances:
-        between two points;
-        from a point to a straight line;

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-     from a point to a plane;
-     between two parallel straight lines.

In engineering practice, it is useful to determine the distance between two points, since:
-     the distance between two points can be assimilated with the need to determine the length of a rafter (valley rafter or not) (fig. 1) or ramps (fig. 2);
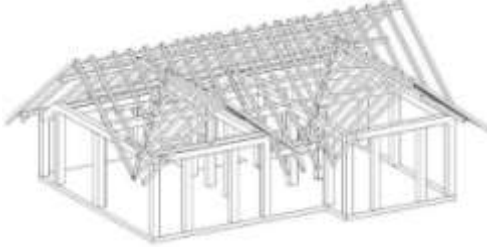

Fig. 1 The representation of a rafter in a residential building

Fig. 2 The representation of a ramp

In Descriptive Geometry, the value of the distance between two points, that determines a line segment that is not parallel to any of the projection planes [H] or [V], is determined using:

1. The method of replacing the projection planes (Marin *et al*, 1998; Precupeţu and Dale, 1987):
    o   of the vertical plane; at the end a line segment$(a'_1b'_1)$is obtained which shows the real distance between points A and B (fig. 3);
    o   of the horizontal plane; at the end a line segment (a_1b_1) is obtained which shows the real distance between points A and B (fig. 4);
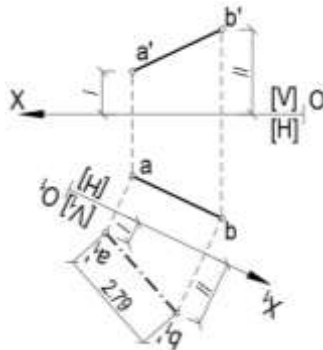

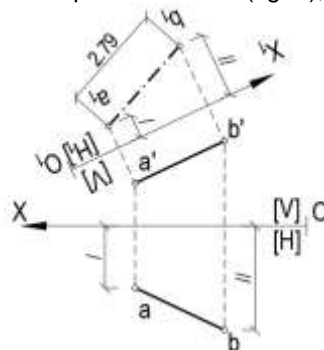**Fig. 3** $(a'_1b'_1)$ is the actual distance between A and B

Fig. 4 (a_1b_1) is the actual distance between A and B

2. The method of revolution, using (Marin *et al*, 1998; Precupeţu and Dale, 1987):
    o   the level revolution, in the end, a straight-line segment $(a'_1b'_1)$ is obtained which shows the real distance between points A and B (fig. 5);
    o   the frontal revolution, in the end, a straight-line segment (a_1b_1) is obtained which shows the real distance between points A and B (fig. 6);
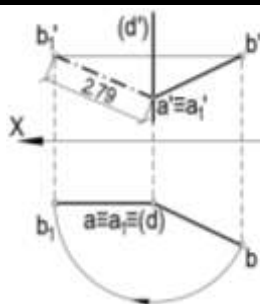
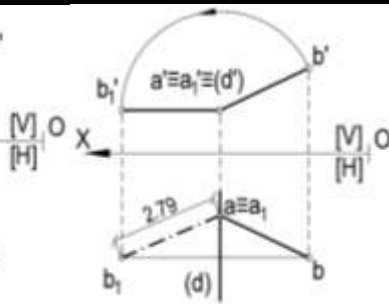**Fig. 5** (a'$_1$b'$_1$) is the real distance between A and B

Fig. 6 (a$_1$b$_1$) is the real distance betweenA and B

As a result of the study conducted in AutoCAD, the authors observed the following:

- the commands for determining lengths, angles or areas (fig. 7) can only be used on objects that are represented in the XOY plane;

Fig. 7 Commands that allow the determination of distances, angles or surfaces

- as the vast majority of these objects are not lying in this plan (fig. 8) the respective commands cannot be used as they provide erroneous information.
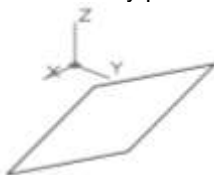

Fig. 8 The plane of the rectangle is not aligned with the XOY plane (visual style:*2D Wireframe*)

The simplest way to solve this problem is to align the plane determined by the two axes with the plane of the object (fig. 9).

Fig. 9 The plane of the rectangle is aligned with the XOY plane (visual style:*2D Wireframe*)

To determine, using the AutoCAD software, the distance between the same points (A and B), the following steps must be taken:

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- the direction of view of the X, Y and Z axes is changing so that, they be positioned as in Descriptive Geometry (fig. 10);

Fig. 10 The directions of the axes correspond to those in Descriptive Geometry

- the two points are represented, by the POINT command, taking into account their coordinates relative to the origin of the system (point O) (Slonovschi and Prună, 2016) (fig. 11);
- the represented points are joined with the help of the LINE command (Slonovschi and Prună, 2016) (fig. 12);
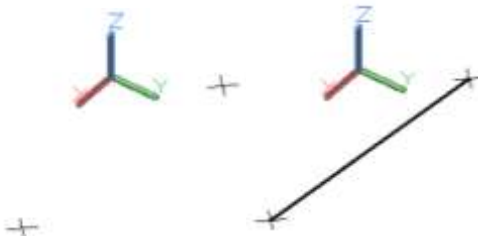

Fig. 11 The points are represented   **Fig. 12** The points are joined

- using the UCS command, the X-axis is aligned with the current UCS of the straight-line segment (fig. 13);

Fig. 13 The X-axis aligns with the current UCS of the straight line segment

- the LIST command is launched (Prună and Slonovschi, 2014);
- the drawn straight-line segment is selected, then the key ENTER <E> is pressed;
- the software displays the properties of the selected object (fig. 14);
- as only the length of the segment is of interest, its value is read next to the word Length, which is currently displayed with 4 decimals (their number can be from 0 to 8).
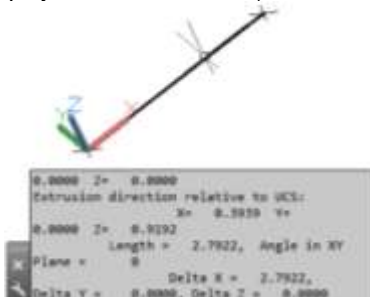

Fig. 14 The software displays the value of the distance between the two points

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RESULTS AND DISCUSSIONS

Figures 3… 6 and 14 show that regardless of the method used to determine the distance between two points the result is the same.

It is also observed that each of the two working methods analyzed differ completely, neither of the working modes having common elements.

Although it is the first type of distance presented in the literature, each of the two working modes requires a deep knowledge of Descriptive Geometry or AutoCAD, because:

- using Descriptive Geometry Methods, a user must:
  - o determine according to a common landmark the coordinates along the X, Y and Z axes of the two points in space;
  - o represents in the draught, the horizontal and vertical projections of the points;
  - o to go through the stages of changing the vertical [V] or horizontal [H} projection plane;
  - o to go through the stages of the level or front replacing planes method.
- using the AutoCAD program, a user must:
  - o to has advanced knowledge of working in 2D and 3D;
  - o to know the commands for representing a point (POINT) and a straight-line segment (LINE);
  - o to know how to work with the UCS command;
  - o to know the command to display the properties of a selected object (LIST) and know how to interpret those results.

From the study it can be seen that both working variants allow obtaining identical results, with the observation that solving the topic using the AutoCAD program offers the possibility to adjust the number of decimals (from 0 to 8), so a higher accuracy in displaying results.

To see practically how to determine the distance between two points, the length of the valley rafter, shown in figures 15 and 16, is determined in both variants, using both Descriptive Geometry Methods (Changing Projection Plans and Rotation Method) and AutoCAD.
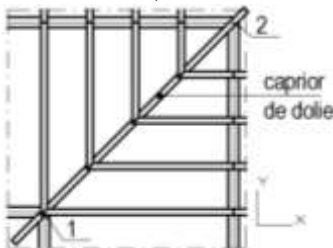

Fig. 15 The valleyrafter (top view)

Fig. 16 The valley rafter (three-dimensional view)

Are known:
- the dimensions of the cross-section of the valley rafter;
- the bearing areas on the wall plate (marked with 1 in figure 15) and on the hip jack rafter (marked with 2);
- level quotas for hip jack rafter and wall plate.
- coordinates along the X and Y axes of the rafter support points (1 and 2).

With these elements, one can easily determine the coordinates along the X, Y and Z axes of point 2 relative to 1. Having these coordinates, the two points are represented and the steps listed above are resumed, noting that and this time the same result was obtained regardless of the method used for solving.

For the other types of distances listed at the beginning of the paper, each of them requires a much deeper knowledge of both Descriptive Geometry and AutoCAD, because:
- using Descriptive Geometry Methods, solving problems requires successive changes of projection planes;
- using the AutoCAD software, solving the problems can only be done if the user knows very well the 3D part of the program and obviously the specific commands.

Finally, it can be stated that both working variants are equally good, the user being the one who opts on one working mode or the other.

CONCLUSIONS

1. Determining the different types of distances (between two points, from a point to a straight line, from a point to a plane or between two parallel straight lines) is particularly important in both the design and execution part.

2. Obtaining these distances can be done both in the classic version (using Descriptive Geometry Methods) and in the modern version (using the AutoCAD software).

3. Regardless of the working method used (classic or modern) problem solving requires in-depth knowledge in the working variant chosen by the user.

4. Both working methods are equally good, the user establishing the working variant that suits him, with the observation that by using the AutoCAD software the accuracy of the displayed distance can be adjusted from 0 to 8.

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