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AUTOCAD Solution for a Roof

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Abstract: The paper proposes solutions for a roof: the classical method using the quoted projection in the descriptive geometry and another method using the AutoCAD program. The results obtained through the second method allow the student to see the spatial representation of the roof and the solving phases, which helps to understand the solution through quoted projection, as well as to form the spatial view and to develop the imagination of the students.
Keywords: descriptive geometry, graphic education, roof, space perception, projections, polyhedral surfaces.

1. INTRODUCTION

The quoted projection is a special projection system where one of the three dimensions (vertically) is much reduced as compared to the other dimensions (horizontally). In the construction field this representation system is very largely used to represent the relief, the earthworks, the communication ways and the roofs.

The roof is an important component of the building, playing the role of ensuring the closing at the top and of protecting the construction from the elements (rain, snow, cold, heat, etc.). Generally, the plane shape of the roof is conditioned by the shape or the building.

The roof is made up of several plane faces (pitches or slopes) that can have the same gradient or different gradients as compared to the horizontal plane. Their main role is to ensure the flowing of waters. The faces of a roof cross each other in twos forming the edges. Designing a roof means determining the intersection lines of the roof faces, which are called ridges when they are convex and crests when they are concave. The classical manner to solve this problem is by using the quoted projection in the descriptive geometry. Another solving method of this problem uses the AutoCAD program.

2. TRADITIONAL SOLUTION FOR THE ROOF

For example, we consider a roof made up of two rectangular shapes, whose ABCDEF contour is presented in fig. 1 in horizontal projection. The slopes of the roof faces are different and therefore the lines of the highest gradient are different. To this purpose, the chosen slopes are:

- for the face corresponding to the AB side the gradient is $p_1 = 1/2$, respectively $i_1 = 2$;
- the faces corresponding to the BC, CD, EF and AF sides, the gradient is $p_2 = 2/3$, respectively $i_2 = 1{,}5$;
- the face corresponding to the DE side has the gradient $p_3 = 1/1$, respectively $i_3 = 1$.

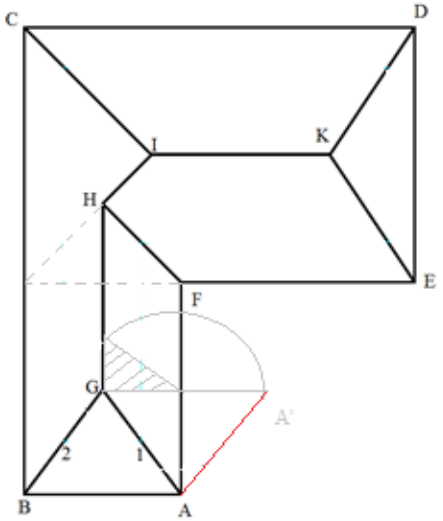

Fig. 1 Horizontal roof projection and determination of the real dimension for the AB ridge (using the folding method)

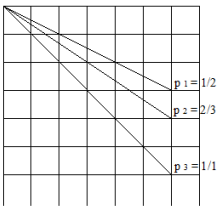

Fig. 2 Graphic scale

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In descriptive geometry the determination of the position of the ridges is done by figuring on each side the semi-circles having the radiuses equal to i_1, i_2 and i_3, presented above.

The values i_1, i_2 and i_3 are graphically determined by using the graphic scale in fig. 2, on which the position of the three gradients is figured in squares according to the scale.

After having traced the semi-circles, the tangents to the circles are traced, parallel to the sides of the roof contour in horizontal projection. The crossing points of these tangents are thus obtained.

By joining these points to the corners of the roof contour in horizontal projection, the projections of the roof ridges are obtained. Further on, by crossing the ridges, two by two, and joining the resulting points, the projection of the roof ridges is obtained.

In the case of the roof, it is required to know the quotas of the extreme points of the ridges and crests in order to be able to determine their real dimensions.

The crests are projected on their real size on a horizontal plane since they are horizontal straight lines, with the exception of the HI crest.

The real dimension of the surfaces of the roof faces is determined by folding the plans of the faces on the level plan of the roof foot.

The determination of the real dimensions of the roof faces is required in order to determine the total surface of the covering. Figure 1 presents, as an example, the folding of the AB ridge in order to determine its real dimension.

3. AUTOCAD SOLUTION FOR THE ROOF

In order to find a solution for the same problem using the AutoCAD program, the procedure is similar up to the identification of the horizontal projections of ridges and crests.

Afterwards, in order to obtain the spatial representation of the roof, corresponding heights are traced from the points G, H, I and K. Their values are obtained from the graphic scale taking into account the grading corresponding to each face.

Further, the ends of these heights are joined to the corresponding corners of the projections in the horizontal plane of the roof. In the last stage the areas of the roof faces are determined.

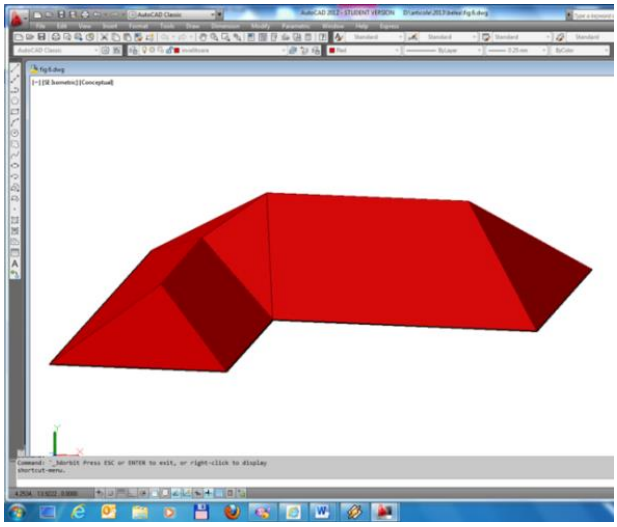


Fig.3 3D representation of the roof

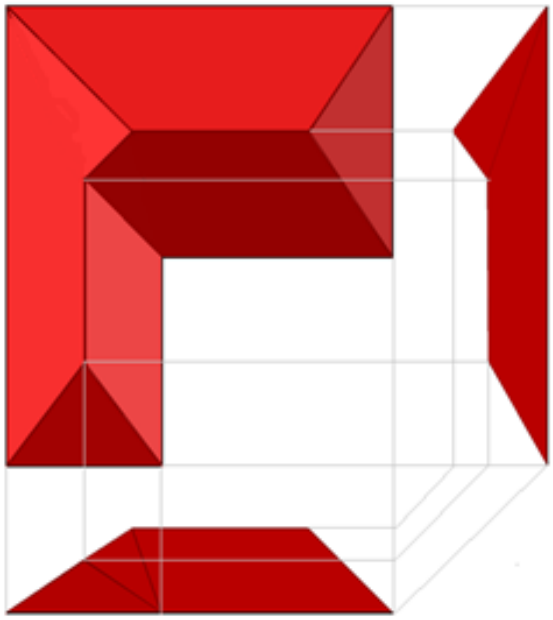
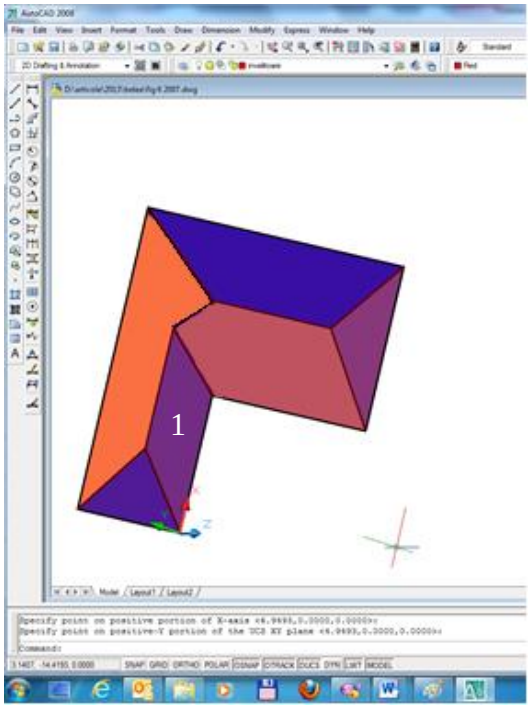


Fig. 4 Draught representation of the analyzed roof

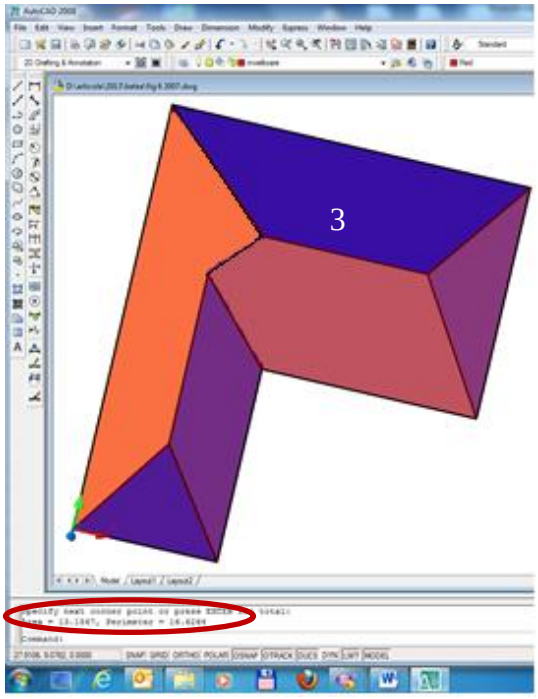
If wanted, besides the view from above, the frontal and side views can be realized, with the help of which the roof draught can be realized (Fig. 4).

In the case of the roofs, an important issue is represented by the determination of the overall surface of the covering. When using the AutoCAD program, this can be realized with the help of the "area" command for all the faces that form the covering. If wanted, in the same time, the perimeter of these faces can be obtained.

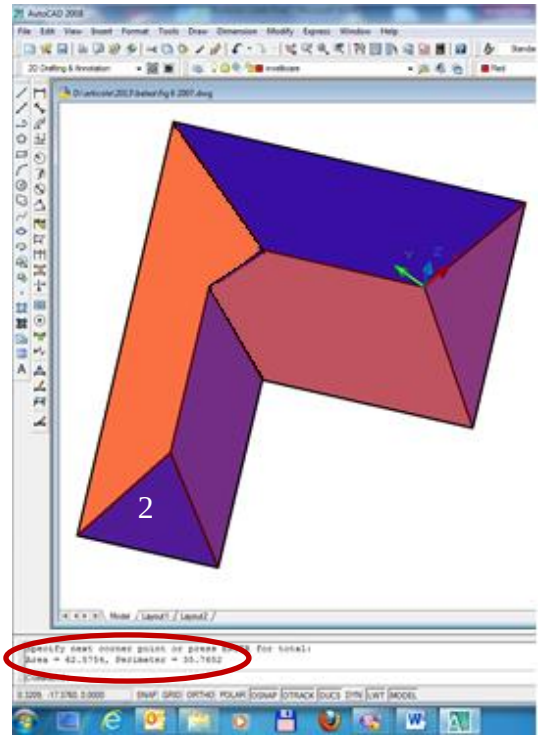
Before applying the command, the UCS position must be altered each time, so that the "z" axis be perpendicular on the face whose area or perimeter we want to determine (fig. 5).



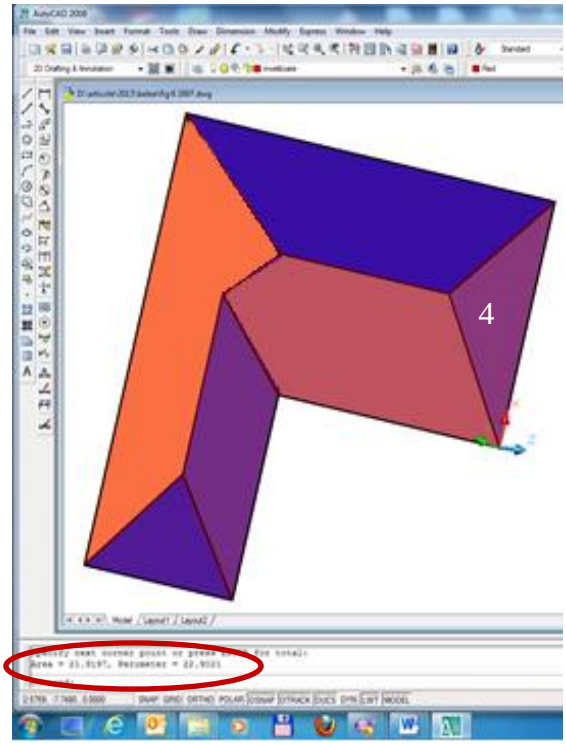
a) for the surface 1



c) for the surface 3



b) for the surface 2



d) for the surface 4

Fig. 5 Removal of the UCS to determine the areas of the covering faces

In order to determine the real dimension of the roofing faces it is required that each surface is rotated around the corresponding gutter. For example, figure 6 presents the unfolding for the faces 1 and 2 of the roof. The other faces are unfolded in a similar way.

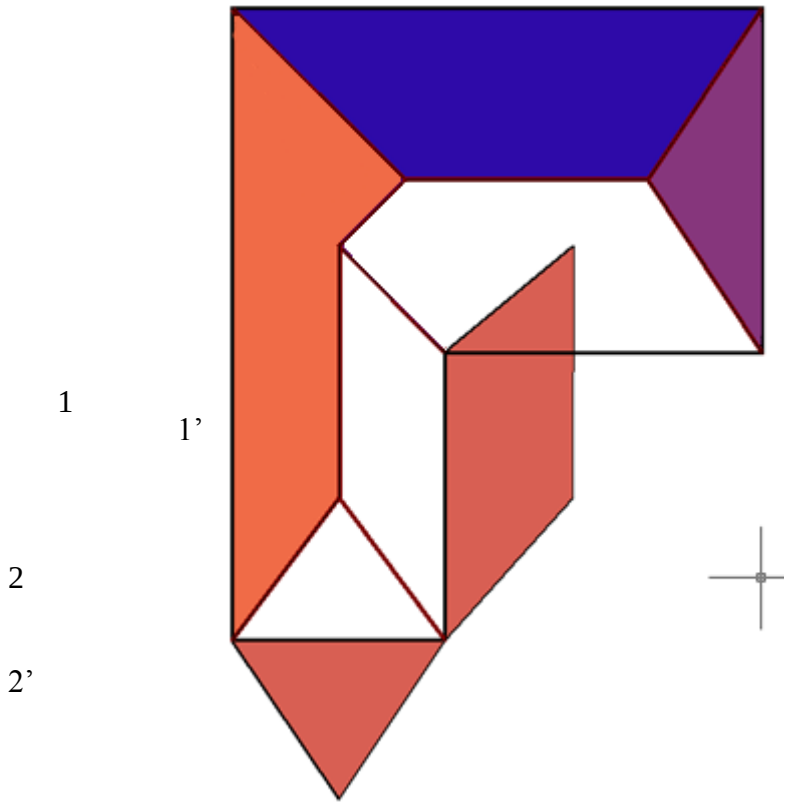


Fig. 6 Determination of the real dimensions for the faces 1and 2 (by using AutoCAD)

4. CONCLUSIONS

The solution of this problem only in a classic manner (with the pencil, tracing square and compasses on paper) is not difficult but it requires good knowledge of quoted projection, the folding method, etc. For the students to understand better the theoretical elements presented in the classic solution for the roof, it is also useful to show the 3D representation of the roof (fig. 3).

Also, the solution of the roof with the help of the AutoCAD program forms the spatial perception for the removal of the UCS and the realization of the 3D folding.

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