DETERMINATION METHODS OF THE UNFOLDINGS OF THE SURFACES USED IN INDUSTRIAL INSTALLATIONS

Carmen POPA [1] Ivona PETRE [2] Vladimir Dragos TATARU [3]

[1, 2, 3] Valahia University of Targoviste, Faculty of Materials Engineering and Mechanics

Unirii Street, number 18-22, Targoviste, Romania, E-mail: carmenpopa2001@yahoo.com

Abstract. *This paper, based on the descriptive and analytical geometry, shows the trace elements of the unfoldings various intersections of geometric corps, the mathematical relations of calculation, necessary to determine some characteristic points. The paper presents some considerations on the theory of unfolding a pyramidal surface intersected with a cylinder surface, and the cylindrical surfaces intersections, using the descriptive geometry and mathematical approach of the problem. As an application, the dimensions of the surfaces are known.*

Keywords: *cylinder, pyramidal surface, intersection curve, unfolding, methods.*

1. INTRODUCTION

The ventilation pipes from the silo link the technological transport equipment with the ventilators and the separation dust catchers. They are made, mostly, of sheets whose thickness is taken according to the diameter pipes. These pipes are made, usually, with a circular section (Figure1).

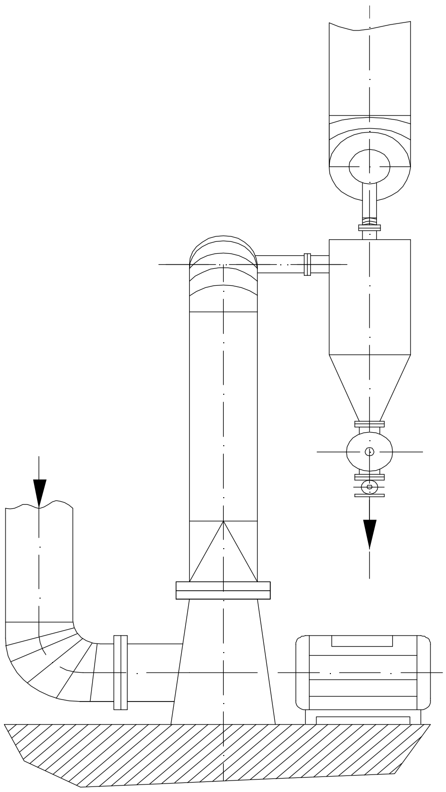

Figure 1. The schema of the dust catcher

To achieve a network of aspiration is necessary, that the first, the main pipe, connected only in a certain way with the secondary pipes of ramification, because any change of direction of the air is causing losses of supplementary pressure. These losses are even greater with the change direction are more sudden. For these reasons, the connections make changes in direction as extended. With both the angle formed by the pipe axis with the axis of shunt bus is lower, with both losses pressure ramifications are lower.

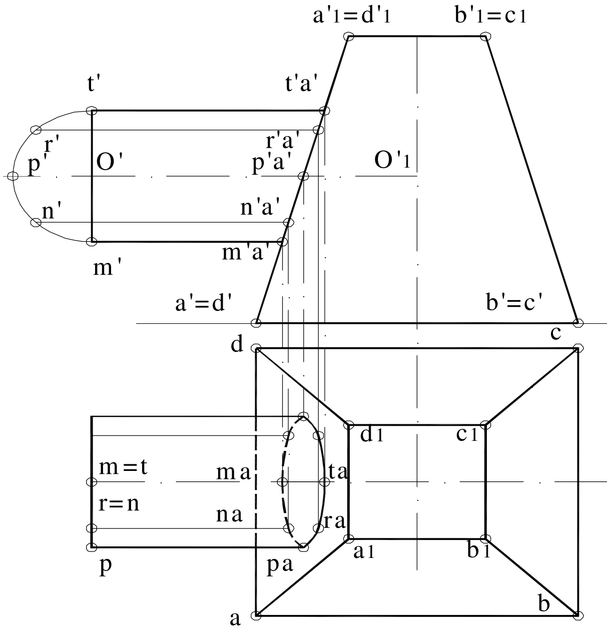

Figure 2. Corps intersections

A decisive role, in achieving of an efficient ventilation installation, they have the sections and the forms of the fluid pipelines. The variety and the big frequency of the calculation and construction problems of the corps unfoldings, used in various industrial installations, made bywrapping sheet, requires a graphical and analytical solving of the encountered cases[1].

This paper aims solving some cylindrical surfaces, that are part of the ventilation and conditioning installations, whose ranges are subject to the limited space and to the assembly possibilities. Drawing the unfoldings and the cutting operation of the iron plates, in order to obtain the bending and joining of parts or assemblies of complex form, is a frequently application encountered in the industrial installations. Need for the economy of material, running the sections of the cylindrical surfaces, how to wrap the material, and so on, are current issues. Although this problem has been addressed often in articles and studies, this paper extends the perimeter of these applications to a field less studied, ventilation and conditioning installations, and not least the approach of the issue.

The paper presents some considerations on the theory of unfolding the cylindrical and pyramidal surfaces solved using the descriptive geometry and mathematical approach of the problem.

The rapid introduction of modern methods to perform various problems in practice, give the possibility of using the computers to solve the unfolding problems.

It is considered that application encountered in practice, the intersection of one cylinder, cylinder C, having the diameter $D = 400mm$ and the trunk of pyramid having the face inclined to 15^0 (Figure 2).

2. DESCRIPTIVE GEOMETRY METHOD

For the case shown in Figure 1, the problem is reduced to the intersection of a truncated pyramid as the $ABCDA_1B_1C_1D_1$ basis, with a OO_1 right circular cylinder, with perpendicular axes.

The points of intersection, between the cylinder with the axis perpendicular on the height of the pyramid, are obtained easily, considering its intersection with a plane (which is the pyramid face that intersect). After the intersection, the $m'a', n'a', ..., t'a'$ points result in the vertical plane of projection.

The cylinder unfolding is a rectangle, with one side equal to the $\pi\overline{MT}$ length of the base circle and the other side equal to the $\overline{m'm'a'}, ..., \overline{t't'a'}$ generators lengths (Figure 3) It is obvious that the true size of the generators is measured in the vertical plane represented. If a more precise unfolded curve of the cylinder is necessary, its base can be divided into several n', r' equal parts. Thus the points of the unfolded curve of intersection will be: $M_oA_o, N_oA_o, ..., M_oA_o$.

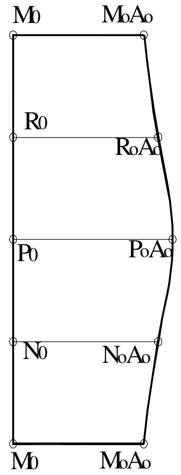

Figure 3. Circular cylinder unfolding

To obtain the unfolding of the truncated pyramid must know the true size of its edges. For this, a pyramid faces rabate on the horizontal plane of projection will be made (Figure 4).

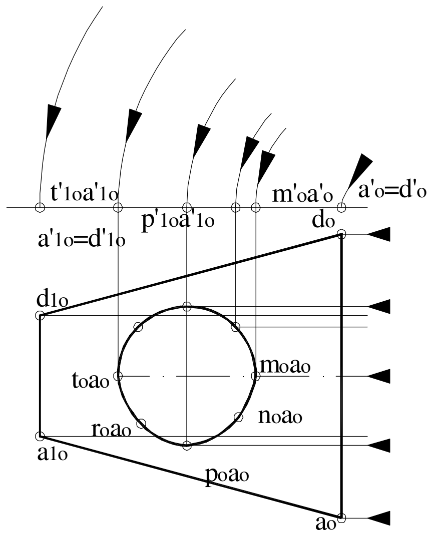

Figure 4. Rebate on the horizontal plane

Thus, it results in true size pyramid edges a_oa_{1o}, d_od_{1o} and the curve of intersection with the $t_oa_o, r_oa_o, ..., m_oa_o$ cylinder. Figure 5 show the unfolded truncated pyramid with the $A_oA_{1o}D_oD_{1o}$ face, where enter the cylinder and the $C_oC_{1o}D_oD_{1o}$ face, the others sides being identical.

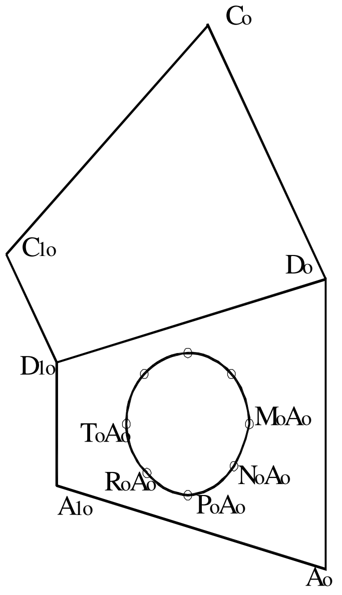

Figure 5. Pyramid unfolding

To determine the connection unfolding, having tor form, is considered that it is composed of sections of cylinders. The unfoldings of these sections are obtained similarly to the case above, resorting to the method of intersection of a cylinder with a plan.

3. MATHEMATICAL METHOD

In the Figure 6 is presented the setting way of the cylinder and the pyramid [2-6].

For the cylinder the equation of the transformation curve, is obtain by applying the transformation (2), (3) to the equation (1).

$$z = x\,tg\varphi,\ x \in [-R, R] \tag{1}$$

$$x = R\sin\alpha \tag{2}$$

$$z = z_d,\ \alpha \in [0, 2\pi] \tag{3}$$

In this case: $x_d = R\alpha;\quad x = R\,sin(\frac{x_d}{R});\quad z = z_d$

Those we obtain:

$$z_d = tg\,\varphi\,(R\,sin\frac{x_d}{R}),\ x_d \in [0, 2\pi R] \tag{4}$$

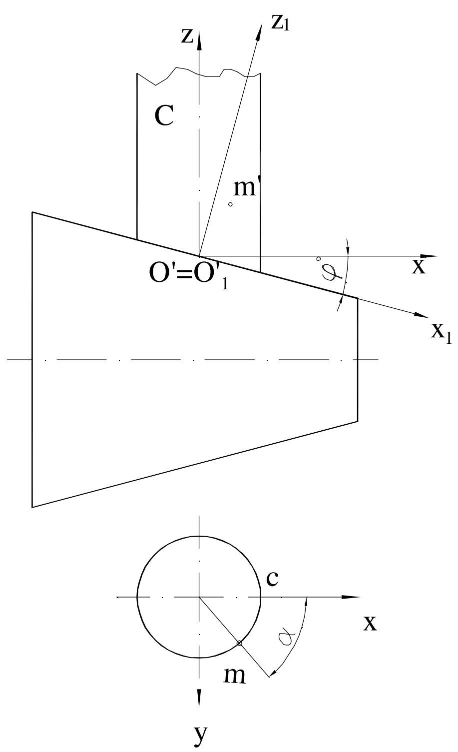

Figure 6. The geometrical elements of the cylinders

For an angle $\varphi = 15^0$ and a cylinder radius $R = 200mm$, we obtain the Figure 7, by introducing the relation (4) into the mathematical program. The Figure 7 show the unfolding for the C cylinder.

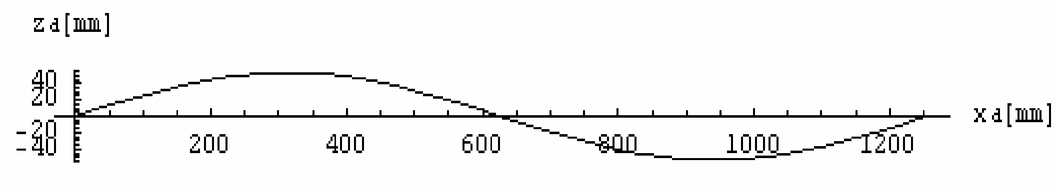

Figure 7. The unfolding of the C cylinder

In accordance with the Figure 6 we take the cylinder C, of diameter D, and its reference system Oxyz and the P pyramid, and its reference system $O_1x_1y_1z_1$, where $y \equiv y_1$ and $O \equiv O_1$.

The equations expressed in the chosen reference systems are:

$$x^2 + y^2 = R^2 \tag{5}$$

$$z = 0 \tag{6}$$

The two reference system are rotated, one given another, by the angle φ. The transformation formulas of the coordinates, to passing from the system Oxyz into $O_1x_1y_1z_1$ and vice versa are:

$$x_1 = x\cos\varphi - z\sin\varphi \quad (7)$$

$$z_1 = x\sin\varphi + z\cos\varphi \quad (8)$$

$$x = x_1\cos\varphi + z_1\sin\varphi \quad (9)$$

$$z = z_1\cos\varphi - x_1\sin\varphi \quad (10)$$

By eliminating the variable x, we obtain the equation of the vertical projection of the intersection:

$$(x_1\cos\varphi + z_1\sin\varphi)^2 + y_1^2 = R^2 \quad (11)$$

$$x_1^2\cos^2\varphi + y_1^2 = R^2 \;/:R^2 \quad (12)$$

In this case the following equation of the ellipse is:

$$\frac{x_1^2}{\frac{R^2}{\cos^2\varphi}} + \frac{y_1^2}{R^2} = 1 \quad (13)$$

We obtain the Figure 8, by introducing the relations (13) into MATHEMATICA program. For comparison, because the circle and the ellipse are closer, we represented the circle, too.

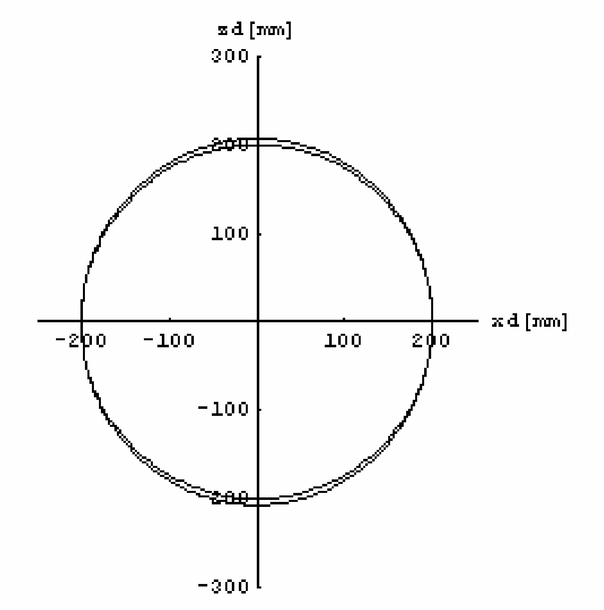

Figure 8. The unfolding of the intersection curve

In the figure 9 is presented the setting way of the cylinders. The transition element presented in the figure 9 is met in this pneumatic equipments.

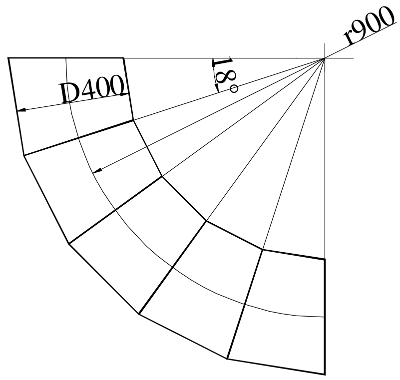

Figure 9. The setting way of the cylinders

For the first cylinder presented in the Figure 10, the equation of the transformation curve, is obtain by applying the transformation (2), (3) to the equation (1).

$$\sin 9^\circ = \frac{AB}{OA} \rightarrow AB = 900 \cdot \sin 9^\circ = 140{,}791$$

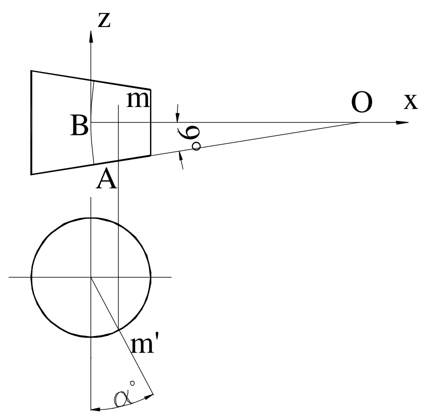

Figure 10. The geometric elements of a cylinder

For an angle φ = 9° and a cylinder radius R = 200, we obtain the Figure 11, by introducing the relation (4) into MATHEMATICA program.

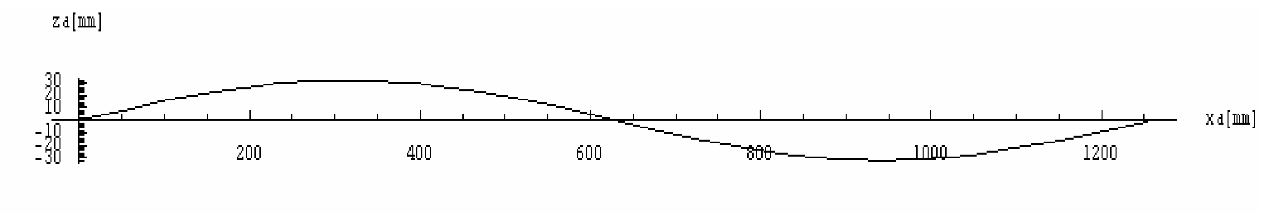

Figure 11. The unfolding of the cilynder

4. CONCLUSIONS

For the correct execution of some pieces or subassemblies with complex form, which meet the requirements, the methods of descriptive geometry are absolutely necessary.

The presented method is very speedy and exactly and using the program we can obtain the corps unfoldings for any other dimensions. The two methods have the same results.

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