THE DEVELOPMENT WITH MINIMUM MATERIAL FOR AN AESTHETIC ROTATION SURFACE

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Abstract.*. In this paper we present the rotation surface obtained by the rotation by the vertical ax of a curved line formed of two equals circle arches. The rotation surface presented in the paper may present interest for the manufacturing of different objects. The approximate development of the rotation surfaces proposed in this paper are based on classic method of descriptive geometry. In the paper are presented two variants for drawing the development surface: the first version with 12 elements and the second version with 24 elements. The second option for the development has the advantage that it uses much less material.*

Keywords: development, rotation surface, aesthetic, circle arch.

1. Introduction

The pieces made from plates are common in industry and are, in certain situations, the only solution of manufacture. The use of plate reduces the piece's weight and simplifies the technology of the execution in comparison with other methods of execution as casting and forging. The layout of the development and the calculation of the theoretic semi-product are necessary for making the technical pieces from metallic semi-manufactured as thin plates. The calculation of the semi-product is also done to save materials.

In this paper we present the development of the rotation surface obtained by the rotation by the vertical ax of a curved line formed of two circle arches. The graphic method adopted is an approximate method and it is similar to gores method from the sphere development.

The specialty literature includes many papers on the developments of geometric solids by approximate methods. The paper [1] proposes practical graphic methods provided by Descriptive Geometry to the development for two revolution surfaces: the revolution surface having an oval as median section and the revolution surface having an ordinary curve as median section. The gores method is presented in many specialized papers, we mention for example papers [2] and [3]. Studies on the approximate developments of some aesthetic rotation surfaces are presented in papers [4], [5] and [6]. Interesting studies on the generation of some esthetic surfaces are given in papers [7] and [8] and in the future we also could study more on their application within the industrial engineering including the whole area problem.

An interesting paper was published in 2015, [9] which presents approximate methods for the development of the surfaces of several technical parts. There are currently many concerns for the study of aesthetic surfaces and their use in the technique field. The paper [10] presents research on some geometric figures with aesthetic shapes. In recent years are used very much the computer assisted methods. An interesting problem of descriptive geometry is solved by two methods, in [11] , computerized method with program Solid Works and method of the classical descriptive geometry.

2. Approximate development of the rotation surface

In the industrial practice there are situations where pieces are obtained from thin sheets by coiling. In some cases, the pieces have geometric shapes that represent different rotating surfaces.

Figure 1 shows the rotation surface obtained by rotating the curve formed of two symmetrical circle arches. The curbed line (PST) describing the rotation surface is formed of the Γ1 circle arch and a symmetrical circle arch Γ2. The curved line rotates around its vertical axis zz'.

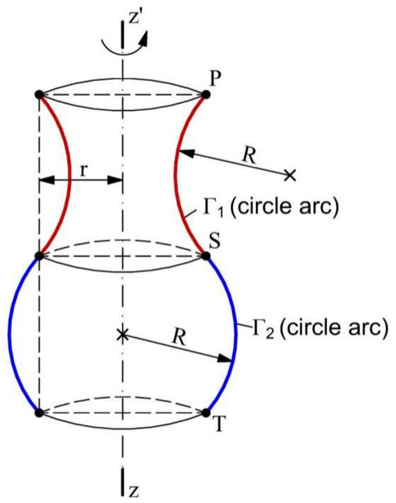

Figure 1. The rotation surface

To determine the deployment, is plotting the projections of the rotation surface in the orthogonal projection system, on the vertical projection plan and on the horizontal projection plan. The projections of the rotation surface are shown in figure 2. It is used the classical method of sphere developed by spherical gores. The auxiliary planes are conveniently selected particular planes and they divide the surface. The proposed case study uses 6 equidistant meridian plans and 7 level plans. In Figure 2, level planes are marked with N_1, N_2, N_3, N_4, N_5, N_6 si N_7 (in the vertical projection plane are noted : n_{1v}', n_{2v}', n_{3v}', n_{4v}', n_{5v}', n_{6v}', n_{7v}'). The sectioning level surface plans determine circles that are represented in a [H] project plan. Meridian section planes are noted R_1, R_2, R_3, R_4, R_5 si R_6 (in the horizontal plan of projection are noted : r_{1H}, r_{2H}, r_{3H}, r_{4H}, r_{5H}, r_{6H}).

The intersections of two consecutive meridian planes with the 7 planar planes and the rotation surface give the points describing a gore. The projection of a gore is given in the vertical projection plane, through the curved line that joins the points: 1'3'5'...17'18'16'14'... 2'.

The surface of the geometric body is divided into 12 elements, named gores. Generally, for n meridian plans result 2n gores. Figure 2 also shows the drawing of a gore. To draw a gore, it is necessary to draw a straight segment M1 M2, with a length L= Γ1+ Γ2. The segment has a length equal to length of the circle arch (PS) and length of the circle arch (ST).The lengths of the circle arch PS are divided into four equal parts and length of the circle arch ST are divided into four equal parts.

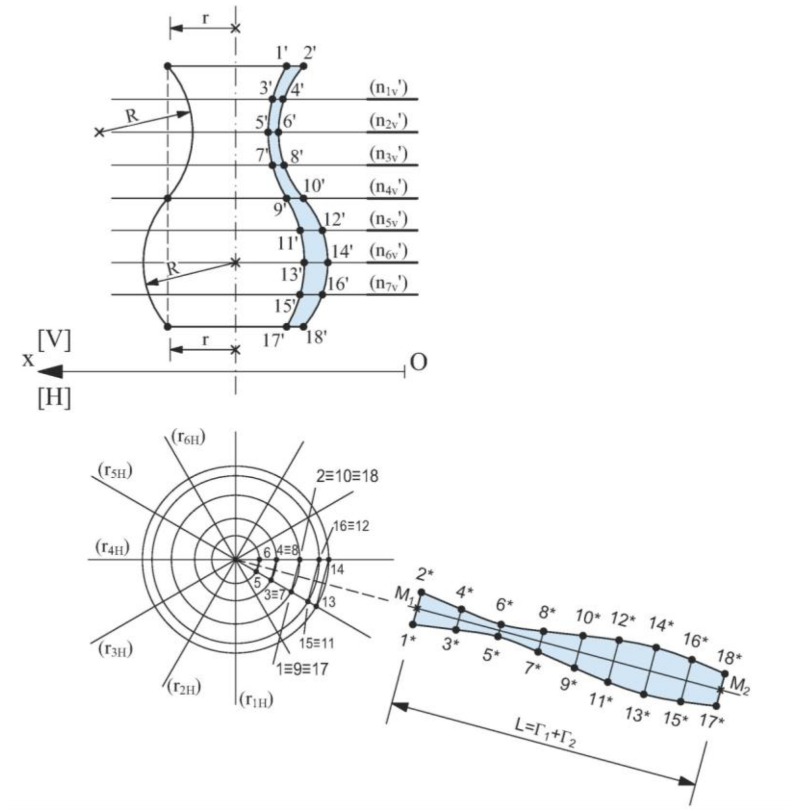

Figure 2. The projection of rotation surface

The number of division points is in correlation with the number of level planes. There are drawn in the dividing points perpendicular segments, symmetrically arranged lengths equal to the strings underlined by the circular arches that are defined by the level planes are plotted at the points of division. In the run of the gore the chords are noted: 1*2*, 3*4*, 5*6*…17*18*. They are joined the points marked with odd numbers by a continuous curve and also the points marked with even numbers by another continuous curve, thus forming an axle pin.

The first development of a rotation surface is given in figure 3 and the development is made up of 12 identical gores. The gores are represented in a vertical position, next to each other, these being arranged along a right segment with length $12 \cdot L_{C(13\text{-}14)}$. It can be noted that the development fits into a rectangle defined by the dimensions L and $12 \cdot L_{C(13\text{-}14)}$.When cutting the 12 fuses, a considerable amount of waste results (free zones between the fuses and the areas at the ends of the rectangle).

For the surface of rotation presented in this paper, the curve Γ1 is symmetrical with Γ2. It is suggested to cut the gores in half. In this case the gores can be arranged in the evolute like this: the upper half of the first gore adhere to the lower half, next it is traced the second gore made of the two joined halves and so on till the 12^{th} gore. It is obtained a development of the surface formed of 24 gores (12 identical elements and another 12 identical elements).

This development is showed in image 4. It is noticed that the development is framed into a rectangle that has the sizes (L/2) and ($12 \cdot L_{C(1\text{-}2)} + 12 \cdot L_{C(9\text{-}10)}$). From the development cutting resulted an extremely small quantity of waste (the waste of material can be found only at the two ends of the framing rectangle).

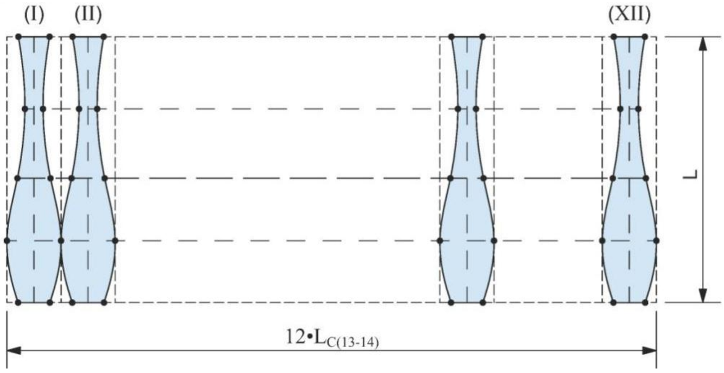

Figure 3. The development of rotation surface (12 gores)

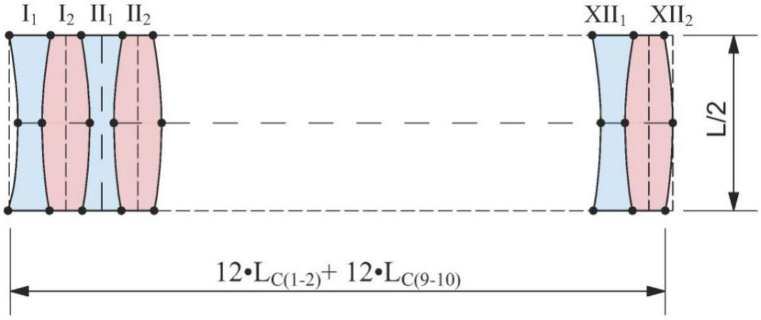

Figure 4. The development of rotation surface (24 elements)

3. Conclusions

The surface of rotation presented in this paper has the advantage of being made from the thin plate by wrapping, after the development was traced. The paper presents two options for the development: the first development contains 12 gores (12 elements) and the second development contains 24 elements obtained by dividing each gore into two parts. The second option has the advantage of using less material because the quantity of waste from cutting is extremely small. The method is inaccurate and the development is designed with graphic errors. The computerized method can be used to reduce errors.

The rotation surface obtained is also a beautiful surface, with special aesthetics, which can find multiple uses. In some applications, it may be necessary to determine the surface to be developed. This surface may have different applications : in industrial engineering, construction, architecture, ambient design.

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