INVESTIGATION OF SURFACE SHAPE OF POLYMER TAPE IN THE COMPOSITE PARTS PRODUCTION

V. Vanin, G. Gryaznova

Summary. **The article describes the research of a polymer tape shape in the production of composite parts of carbon polymers.**

Keywords: **winding, composite materials, fil'yer, threaded surface Monge.**

Formulation of the problem. Consider some questions that arise in the design and creation of adaptive robotic winding machines equipped with vision systems used in the production of parts with composite materials. Modeling adaptive control system allows controlling complex nonlinear movement of reinforcing the executive arm according to the shape of the mandrel and given the characteristics of the composite. Automation of the entire complex control and process control winding parts with complex geometric form of fiber composite materials is important.

Analysis of recent research. The problem of automation equipment, winding through the geometric design of process improvement and adaptive winding machines with vision systems considered by several authors [1,2]. The researchers [1] for the mathematical description of the method opravok surfaces Koons, based on creating three-dimensional objects. Another class of objects created using parallel flat sections at a point frame. The authors [2] studied the basic scheme of reinforcement products in the form of surfaces of rotation using a flat polymer tape.

The wording of Article purposes. This paper deals with the study of the geometry of the fiber ribbon opravok different shapes and related aspects of improving parts of the guide winding machines.

Main part. Consider the process of the imposition of a flat composite tape that is in tension on the outer surface of the mandrel cylindrical Δ' (Fig.1). One end of a given strip width is fixed on the surface Δ', and the other on her wound. Then the line *AB* that the output filer Drum describes surface Δ, which is threaded surface Monge [3,4]. *AB* - its profile, the axis of rotation in every moment changes its position and coincides with the generatrix Δ'. Thus, Δ 'is evolute surface Δ. The surface Δ has two lines of curvature, meridians *m* (eg, *AB*, *CD* in Fig. 1), and curves *AC*, *BD*, which are orthogonal trajectory points go. Evolute *LFK* and *ERS* - geodetic line Δ'.

If the surface is cylindrical guide, all of the parallel line is flat, located in parallel planes, generating orthogonal guide cylinder.

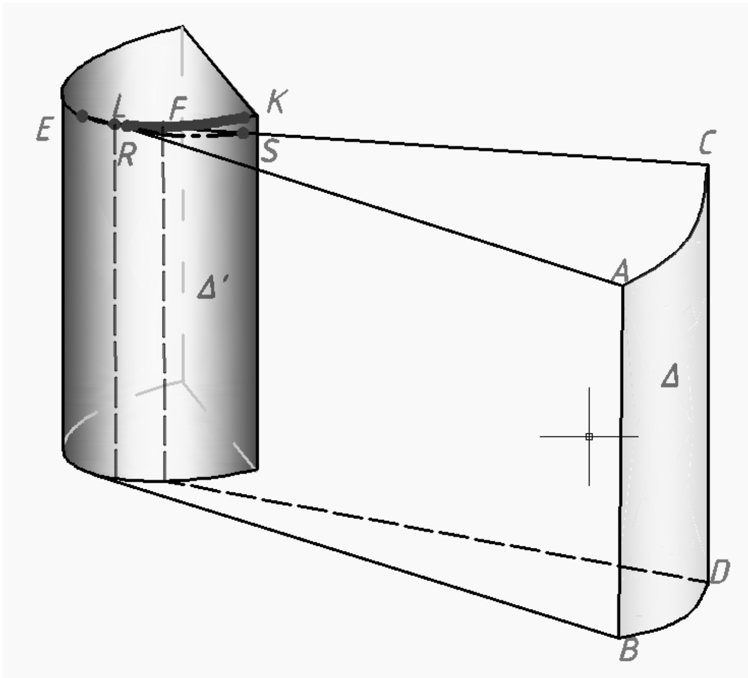

Fig.1. Monge threaded surface during the winding mandrel at a cylindrical shape.

Fig.2 shows Drum part in the creation of the outer layer in the shape of a torus. Consider forming part of the tape in filer (Fig.3), which corresponds with the winding mandrel surface *A*, and is due to bending flat strip *B* constant width.

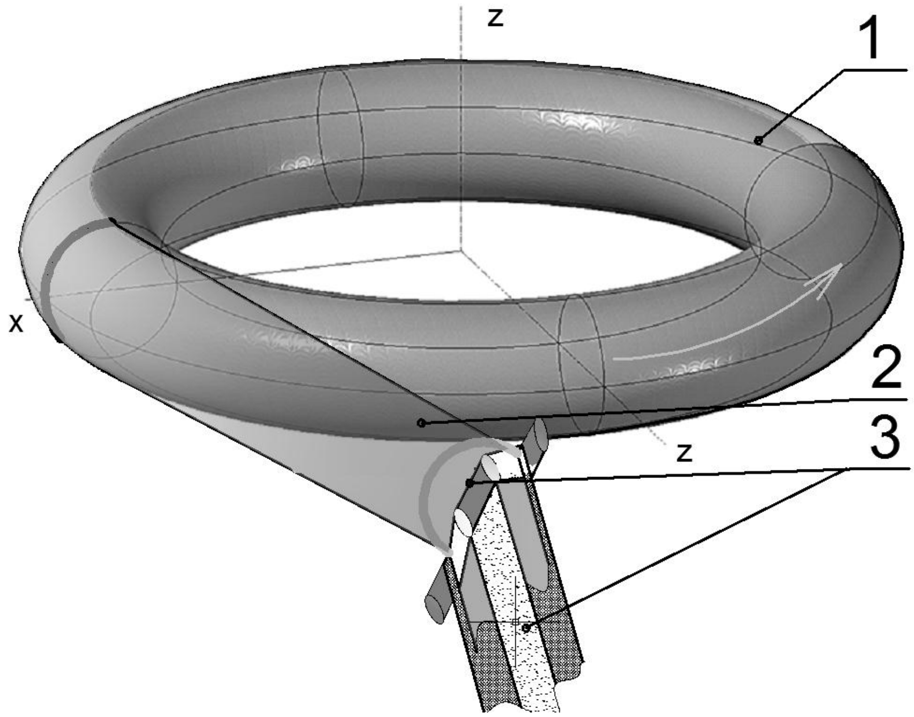

Fig. 2. Laying polymer tape on the outer surface mandrel in the shape of a torus: 1 - mandrel; 2 - polymer tape; 3 - filer system with guide rollers.

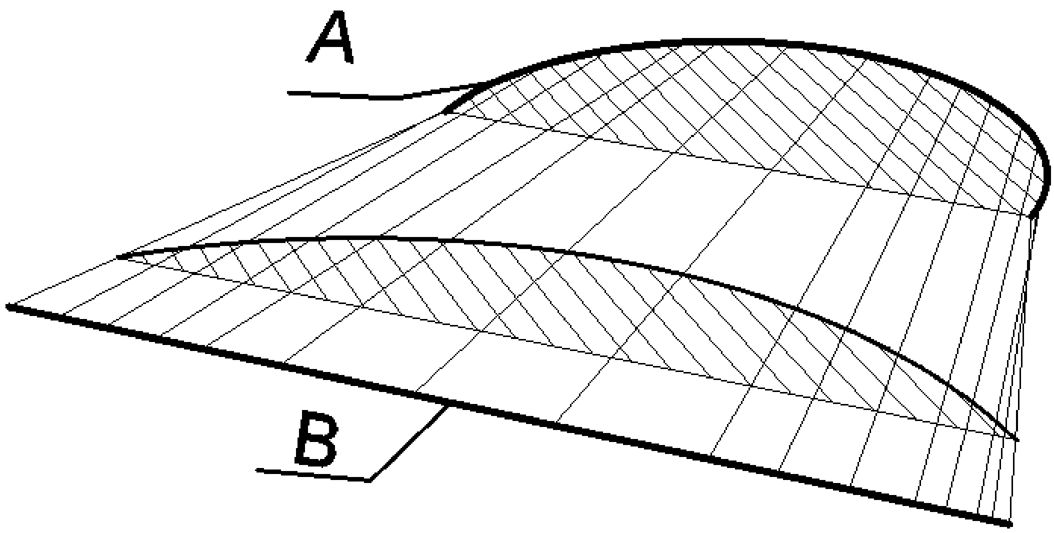

Fig. 3. The form polymeric tape from the mandrel A to exit filer B.

The question of calculating the width of the tape for winding one layer of a given surface. If *A* curve can be set or approximated using continuous function and has a continuous derivative in this segment [a, b], then its length can be calculated by the formula [6]:

$$|L| = \int_a^b \sqrt{1 + f'^2(x)}\,dx. \qquad (1)$$

If the curve L defined by the polar equation $r=r(\Theta)$, $\Theta_1 \le \Theta \le \Theta_2$, and the function $r(\Theta)$ and is continuous on the segment $[\Theta_1, \Theta_2]$ a continuous derivative, then the curve *L* may be for straight, and its length is calculated as follows read:

$$|L| = \int_{\Theta 1}^{\Theta 2} \sqrt{r^2(\Theta) + r'^2(\Theta)}\,d\Theta. \qquad (2)$$

If the task of the curve in parametric form:

$$x = \varphi(t);$$
$$y = \psi(t); \qquad (3)$$
$$z = \chi(t);$$

and if the function (3) are continuous and have continuous first derivatives on the segment [α, β], the length of the arc can be found using the formula:

$$|L| = \int_{\alpha}^{\beta} \sqrt{\varphi'^2(t) + \psi'^2(t) + \chi'^2(t)}\, dt. \quad (4)$$

Conclusions. The method accurately calculate the width of the tape at reinforcing products of any geometric shape. Further research concerning the process of winding polymer layer on the inner surface of the product.

Literature

1. *Аюшев Т.В.* Геометрические вопросы адаптивной технологии изготовления конструкций намоткой из волокнистых композиционных материалов / Т.В. Аюшев. – Улан-Удэ: Изд-во БНЦ СО РАН, 2005. – 212 с.
2. *Куценко Л.М.* Поверхні обертання зі змінної уздовж осі кривиною меридіанів та їх зміцнення шляхом намотування кевларової нитки / Л.М. Куценко, С.Ю. Руденко // Міжвузівський збірник "Комп'ютерно-інтегровані технології: освіта, наука, виробництво . – Вип. 6. – Луцьк: ЛНТУ, 2011 р. - с. 148-153.
3. *Рекач В. Г.* Расчет оболочек сложной геометрии / В.Г. Рекач, С.Н. Кривошапко. – М.: Изд-во УДР, 1988. – 176 с.,ил.
4. *Выгодский М.Я.* Дифференциальная геометрия / М.Я. Выгодский. – М.: Гос. изд-во технико-теор. л-ры, 1949. – 511с.
5. *Ванин В.В.* Эвольвентно-эволютные модели в упорядоченных потоках: дис….д-ра техн. наук: 05.01.01 / В.В. Ванин. – К.: КПИ, 1996. – 415с.
6. *Андреев Г.Н.* Дополнительные главы геометрии. Дифференциальная геометрия кривых и поверхностей: Учебное пособие / Г.Н. Андреев. – М.: МГИУ, 2007. – 183 с.