

THE USE OF 3D GEOMETRIC MODELS IN SPECIAL PURPOSE KNITWEAR DESIGN AND PREDICTING OF ITS PROPERTIES

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Abstract: The article deals with the issues of predicting special purpose knitted fabrics properties. We suggest solving this problem by designing a 3D geometric model of a knitwear structure. The proposed technique has been used to design a 3D model of a double-layered knitwear structure, which is used for ballistic protective clothing manufacturing

Keywords: 3D modeling, weft-knitting, loop length, B-spline, knitted structure, yarn central line geometry, special purpose knitted fabrics, personal protective equipment, armor protection.

INTRODUCTION

The special purpose knitted fabrics for personal protective equipment have to meet a number of requirements for physical, mechanical, hygienic and other properties, as they are subjected to various types of force application during wear. They are made of high tenacity threads and are used to protect users against the following risks: effects of small arms projectiles; effects of shrapnel from explosives; effects of stabbing and cutting weapons. Clarifying the relationship between threads characteristics and their configurations in an interlooping structure on the one hand and protective properties of fabrics on the other hand is a difficult task which demands a special approach and accuracy [1, 2].

Designing of a special purpose knitted fabrics is concerned with choosing the optimal physical-mechanical and geometric characteristics. In this project we have discovered the ways to solve the problem of properties optimization of personal protective equipment based on the analysis of the characteristics of the input materials by using universal computer simulation systems. Such systems perform the analysis of physic-mechanical objects under investigation on the basis of their 3D geometric models. Therefore, one of the crucial points for an imitation research of the reliability of individual armor protection products that are made of high tensile strength knitwear is the adequacy of the mathematical description of its structure. It is known that BFS depth deformation of knitted fabrics is connected to the redistribution of the yarn in the knitwear structure. Thus, the model, which is used to assess the reliability of armor protection has to coincide with the shape and the loop length of the real prototype.

RESULTS AND DISCUSSION

The task of predicting of the special purposes knitted fabrics properties is proposed to be solved by constructing a 3D geometric model of the knitwear structure. 3D geometric modeling of the knitted fabrics structure requires an exact display of the configuration of the axial line of the yarn in its structural elements [3,4]. To describe the configuration of the yarn central line in the loop of the plain-knitted structure the authors have used the mathematic theory of B-spline construction. In the model, the length of the spatial curve varies with the

change of the inclination angle of the tangent at the interlacing point as an independent variable. This makes the model flexible and feasible for use in 3D modeling systems where the loop length of the virtual knit pattern must coincide with the loop length of the real prototype. The suggested technique is realized at constructing of a 3D model of the structure of double-layer knitwear made of high tenacity polyester yarn. We have generated the models of the knitted fabrics structures by using software which was developed by us [5].

On fig. 1 and fig. 2 image of a virtual sample of a plain-knitted structure fragment and a 3D structure of a double-layer knit with tuck connection of layers built by the means of this program is shown [5].

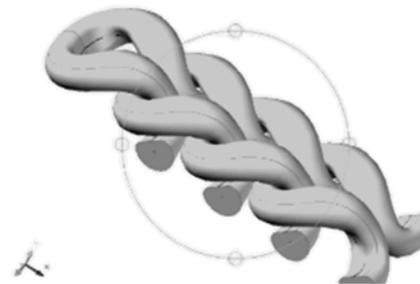


Figure 1 3D geometric model of a plain-knitted structure

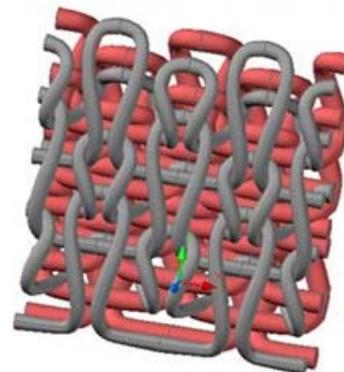


Figure 2 3D geometric model of a weft double-layer knit with tuck connection flayers

When designing special purpose knitwear for fencing clothing manufacturing, virtual models allow us to predict its pressure bearing capacity against multiple impact points caused by a tip of a fencing weapon; to visualize the hits of the blade tip on the stitches and predict their deformation; to design an optimal knitwear structure with the specified physic-mechanical properties [6].

During experimental research we produced the weft knit structure samples made of different raw materials and studied their structure parameters. For each sample we designed a 3D model with geometric parameters that coincide with the real prototype parameters. We defined the angle values at tangent point of a fabric for each sample. Value of an independent angular parameter used as an independent variable γ , changing of it allows getting a spatial curve of a necessary length.

CONCLUSIONS

The results of the conducted researches testify to the high level of conformity of the 3D model, namely, by the parameters of the loop length, course spacing and wale spacing the real parameters of its structure.

Further researches will focus on defining the relation between the independent variable γ and yarn physic-mechanical properties which will allow using the developed technique for predicting the stability of knitwear to various dynamic loads without making a sample on knitting equipment.

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