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THE GROUND OF TEXTILES KINEMATIC PACK AS GENERALIZED ELEMENT OF THREAD STRUCTURES

Приведена доцільність і обґрунтовування нового об'єкту (поняття) «текстильні кінематичні пари» з ниток (пряжа) які мають плоску або просторову структуру з текстильних вузлів різних переплетень і повторюються в рапорті текстильних матеріалів. Доведена спільність існування текстильних кінематичних пар в текстильних матеріалів різного походження, а саме: ниткових стьобаннях, строчках і швах, які проводяться на швейних машинах, тканинах, які проводяться на ткацьких верстатах, трикотажі, який виробляється на трикотажних і в'язальних машинах, шнурах і канатів, який виробляється на шуноплетельних і шнуров'язальних машинах

Ключові слова:текстильні кінематичні пари,просторова структура, пряжа

The classic notion of kinematics pack is following: kinematic pack is contact mobile connection of two links with motion relation ,which are limited by the terms of contact communications imposed on. Depending on the area of contact kinematic packs are divided into higher (contacts in a point and on a line) and lower (contact on an area) [1]. Expedient additions to structural classification made by AuthoreArtobolevskiy were done in the work [2], and at this article the work is continued on expansion of notion is continued «kinematic p.» and the new notion «textile kinematic p.» (TKP) is grounded here. The notion is swum out from the resulted classic determination of kinematic pack and can be used for researches and for planning of mechanical technologies in textiles productions.

Object and research methods

Textile kinematic packs, which are the mandatory member of inexact structures of textile materials and will be used in making of clothes, shoe,knit wares and wares of special and technical setting are a research object. Research methods are the systems of analysis and synthesis of the complex mechanic-technological systems at object- the oriented planning (OOP) [3,4].

Raising of task

Presently at technical, scientific, reference and educational literature, and also in Internet - the electronic reference book «Wikipedia», the notion «textile kinematic p.» (TKP) is absent. The notion exists in reality in the real mechanical technologies under different names: «knots of interlacing of filaments» of needle and shuttles or «knots of interlacing of needle filaments and filaments of loop formers»[5], «knots» [6], «loops, loads and floats of the knitting interlacing» [7], «knots of interlacing of filaments of warp and weft» [8], «Chebishevsca network» [9, 10] and otherTKPare the elements of key structures of thread from filaments and yarns(fibers) ,which aremade with farms with resilient links . They are the deformation state of segments of filaments of direct or curved-linear forms. The necessity of introduction of TKP notion is conditioned to those filaments and yarns made from fibers textile or chemical (synthetic or artificial) are the physical object, and a knot is the mathematical object.The attention to this special feature was paid in this work [11, 12, 13] and by other authors of works on mechanics of textiles. Through that number of works there are the works on mechanics of filaments and fabrics.

TKP is a basis for the calculation of parameters of loop structures which are laid in the algorithms of metrical synthesis of mechanisms of the special purpose setting.

The mechanisms of loop-formation of knitting machines (mechanisms of knitting) belong to such mechanisms, mechanisms of needle, shuttle/ shuttles, thread-pulling and feed dog of sewing machines, mechanisms of feeding of warp, batan, yawn-formation and shuttle of looms, mechanisms of twisting and reaching of textile and interlacing machines, mechanisms of knitting - sewing machines and the others.

Results and their discussion

To determination«Textile kinematic packs» (TKP) we will give the next formulation. TKPis the splays connection, that it is formed by interlacing from one and greater amount of textile threads or yarns, which are interlaced with a new functional setting and new physic-mechanical properties of thread and are appeared as a result. Splays joints in production of textile materials and wares are originated from the keyword of «splays».

In the basis of classification of TKP it is laidthe following geometrical and physic-mechanical models of TKP, from which the generalized parameter swam out, - the area of contact of filaments(yarn) in loop or its derivative:

TKPof 1 class or 1D-TKP, which are formed from fibers or filaments in the basic external loading of twisting and drawing out along TKP (Fig.1a, Fig.2a);

TKPof 2 class or flat 2D-TKP, which are formed, for example, in making of fabrics (Fig.1b, Fig.2b);

TKP of 3 class or 3D-TKP by volume, which are formed, for example, in making of the knitted fabric and sewing stitches (Fig.1v,g and Fig.2v,g); TKP of 4 class or TKP - combined, which are formed by a different connection of 1D-TKP, 2D-TKP and 3D-TKP, which are formed, for example, in connection (to treatment) of textile materials by or chain lines shuttles (by stitches).

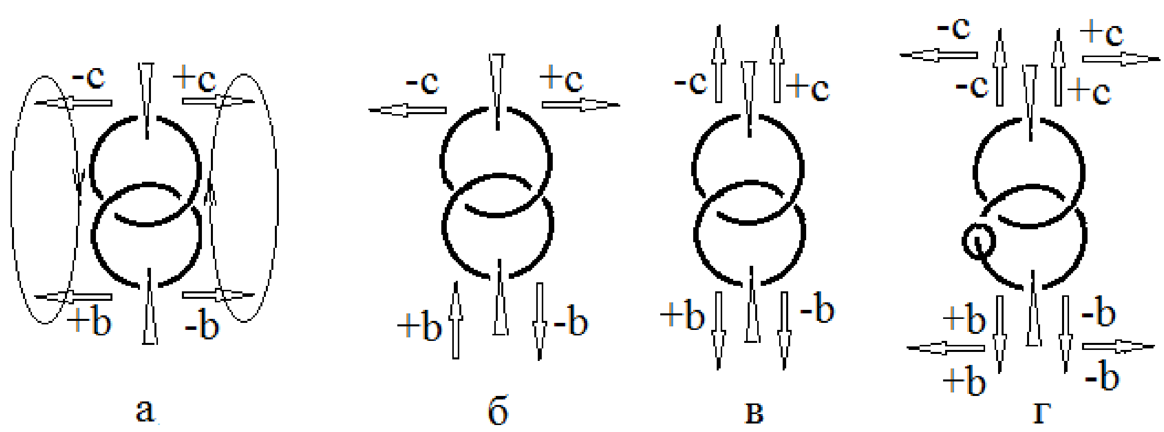

Fig.1.**Sheme on structural found actions ofTKP first class (type) - right key structure**

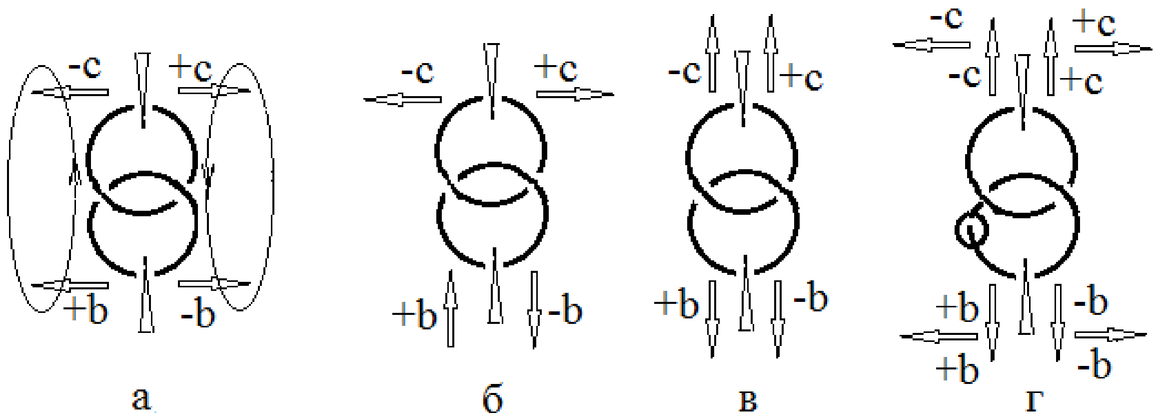

Fig.2. **Charts of structural found actions of TKP secondclass(type) - left key structure**

Structure of interlacing of thread it is the great number ofTKP, which are appeared by the scission of knot as the two or more of the interlaced rings with a next breeding and drawing of the cut ends out in sides.

If ends (+c) and (-b) and (+b) of the cutting rings are divorced on a corner b=r/2 radian and begin them to twist up clockwise and anticlockwise, the TKPs of the 1 class of class first (type)(Fig.1a) are appeared, if ends are divorced to twist up anticlockwise and clockwise the TKP of the 2d class of class first (type) are appeared. (Figure 2a) .

If ends (+c) and (-s) and (+b) of the cutting rings are divorced b=r radian on a corner, theTKP of the 2d class of 1 and 2 modifications are appeared, accordingly (Fig.1b and Fig.2b).

If ends (+c) and (-s) and (+b) of the cutting rings are drawn aside in opposite sides (corner b=0), as represented on Fig.1v and on Fig.2v or divorced b<r/2 radian (Fig.1g and Fig.2g) on a corner, the TKP of the 3d class of 1 and 2 modifications are appeared, accordingly.

If a ring is cut to depict as a marble which moves after the route of the cutting ring (loop in a loop), for all classes we will get TKP with a grade on 1 number greater. The number of marbles can be greater than two ones. The last characteristically for the great numbers of TKP offabrics and knitted fabric of different reports and structures of interlacing. For example, press knitting loop with the two loads in one cutting ring (by two marbles) forms the TKPof 3d class of 2th grade of 1or 2 modifications.

And the shuttle stitch (TKPof the3d class of 1th grade) , which is jointed with two to the layers of fabric of the linen interlacing (TKP 2th class of 1th grade) by means of sewing filaments of right twisting in a 3 drafting (TK of the 1 class of 1th grade of kind 3) form the TKP 4th class with a code: 3.1+2.1+1.1.3v.

On Fig.3 the transversal cuts at 5 level (+2 +1, 0, -1, -2 with an even step) of typical textile kinematic pack of 3th class of the1 grade with a knot right and left are resulted. Ends of overhead filament of marked «+b» and «+c», ends of lower filament of marked «-b» and «-s», and denotations of «b» and «s» belong tothe cut (shading) and to the whole filament in the change to the sign on opposite one. At level of «0» and ±a 1 area of cuts has the appearance of 4-listniciv without brake and with one 2-listnicom that is formed on the type of joint of soapy marbles.

The analysis of the resulted cuts allows to do a conclusion about the area TKP contact, which has the appearance of crossing of two 3-D ellipses with a corner between largeaxises of ellipses which is the function of parameters of filaments physic-mechanical and technological parameters of filaments. This conclusion can be generalized for TKP 2th and 3th classes.

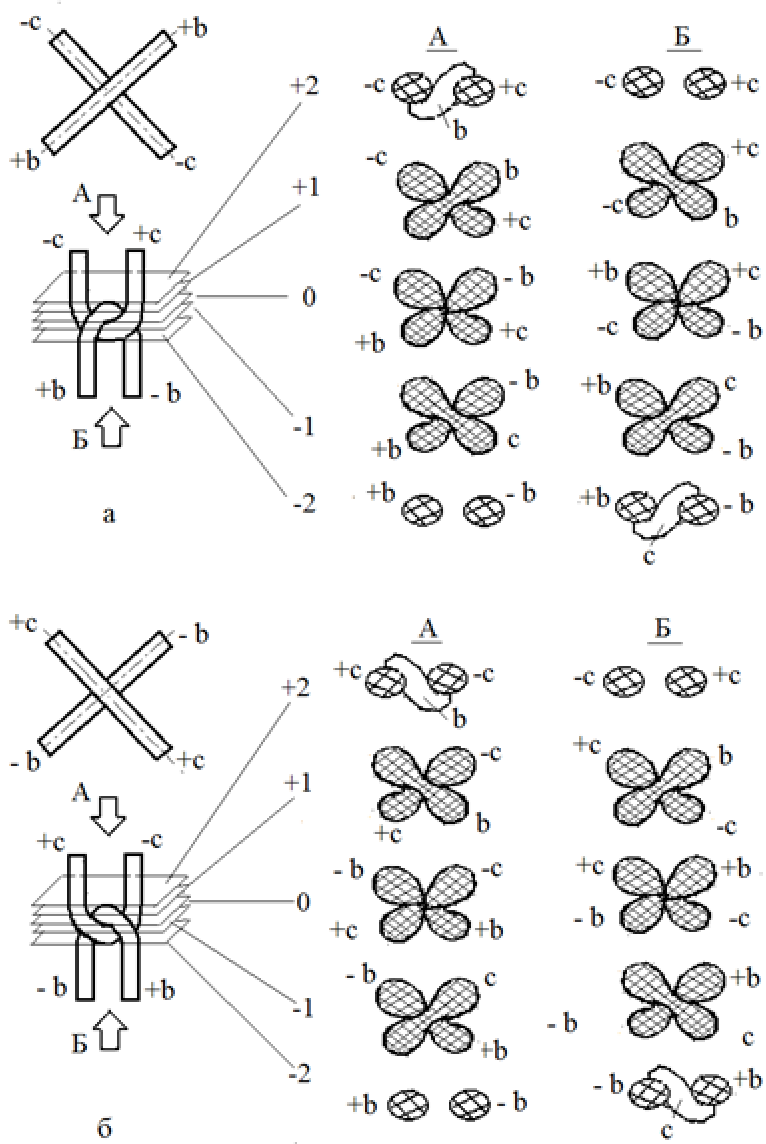

Fig.3. **Change of area of the transversal crossing of the TKP of the 3dclass of a 1 grade:**
***a* – class first (type); *b*-class second (type); *A* and *B* – type of crossing of from above and from below, accordingly**

Planning of TKP, as an object of computer – aided design and as an object of mechanical technology of formation (forming) of structures of thread on the technological equipment is connected with basic principles of the object - oriented planning, namely - principle of encapsulation, principle of polymorphism and principle of inheritance.

The principle the «encapsulation ofTKP» at the Object – oriented analysis and synthesis of structures of thread is based on association in one whole of parameters of filaments (yarn), which are entrance given (by the fields) TKP and modes of mechanical technology of education TKP (interlacing, crossing, throwing, reaching, tightening and in.), which are an algorithm (by a method) TKP, geometrical and physic-mechanical.

The principle the «polymorphism of TKP» will be used in the object - oriented analysis and synthesis of structures of thread for «objects», which have not a general ancestor and use different algorithms (methods) for mechanical technology of education TKP, that is belonged to different classes, for example «object-filament» and «object-works instrument».

The principle of «inheritance of TKP» at the object - oriented analysis and synthesis of structures of thread is based on property of TKP to derive the descendants as «objects-descendants» which automatically are inherited from the «objects-parents» all data (fields) and algorithms (methods) of mechanical technology. «objects-descendants» TKP can complement thus, deputize or recover «objects-parents» by new fields and methods.

Mechanical technology of forming ofTKP in time on technological machines takes place at different correlations of normal deformations (at the stretch) and deformations of change (at twisting) of mobile filaments (yarn) under different flat and spatial corners of contact of co-operation of filamentsin a knot. Thus forces of resistance of motion of filaments forreological models of Celvina-Foyhta or by a model of Macsvella [14,15] prevail above forces of friction after a model ofSen-Venana in the area of contact of filaments. After formation of the TKP filament and TKP temporally immobile (to the moment of beginning of exploitation of textilegoods and TKP is found at static to the equilibrium. The filaments of force of resistance thus dissipated on length accumulate and loop – former in the area of contact TKPin contact tension. Thus it takes place the balance forces of resistance and forces of friction with formation of micro - volume of composite material from two layers of different materials of filaments. This micro - volume of composite material is found in an equilibrium up to beginning of exploitation of textile goods. Thus TKP iscontsentrationof normal and tanget tensions and from the point of view term of exploitation and reliability ofTKP on the stage of planning of textile goods needs to mortgage (to forecast) of the resource of exploitation, and on the stage of exploitation of textile goods needs to mortgage (to forecast) a remaining resource the TKP works.

Therefore the scientific ground of (prognostication) resource of the TKP work is the issue of the day for textile material – knowledge science and mechanics of textiles. TKPs are appeared from one or a few systems of filaments or loops from filaments. At first the filaments are found in the mobile contact with friction of sliding, and then passed to the immobile contact which is saved to beginning of exploitation of goods. The 3d class of typical TKP 1th grade forms two filaments in a loop with the corner of scope between its branches.

The examples ofTKP are:

knots of interlacing in textile material or under the package of textile materials of two or more filaments or loops in a stitch, line and quilting of thread;

knots of interlacing of loops, loads and floats in regular structure of knitting linens;

knots of interlacing of filaments of warp and weft in the structure of fabrics;

knots of interlacing of filaments in making of the special wares of type of cords, ropes, nets and composite materials;

knots of interlacing of fibers in a yarn in twisting and drawing out in spinning production.

Two systems of sewing filaments in the form – formation of shuttle and chain machine stitches shuttles of thread part are taken, as a rule. One system of filaments belongs to the needle (to the needles), and other system of filaments belongs to the shuttle (to the shuttles) or loop - former (loop -formers). These two systems of filaments are located for different sides of materials, which areunited by the stitch of thread and during work of sewing machines are interlaced between themselves in the layer of materials or under the package of materials in making of clothes, shoe, knitwears, head-dresses and articles for special and technical purpose, that do not belong to the clothes.

TKPs in the wares of production of sewing, knitting, spinning, weaving and special manufacturing appear as knots from textile filaments in transformation of forces of friction of rest and friction of sliding in forces of ductile resistance. In TKP the deviation from a monomial law byGiyonaAmontona also takes place:

$$F_{fr} = f \cdot N \qquad (1)$$

where – coefficient of proportion (coefficient of friction); – force of normal pressure.

By deviation of direct proportional dependence of force of friction from force of normal pressure in a loop it is related to internal forces of coupling between fibers in a yarn (filaments) and external forces of coupling between filaments. Thereforethe two - members law of friction bySharlyo Coulomb can be most acceptable:

$$F_{fr} = A + f \cdot N \qquad (2)$$

where - force of coupling of two bodies

At forming of loops from textile filaments, when at co-operation of loop – forming working organs of technological machines of filament mobile expression (2) adopts a kind:

$$F_{fr} = f \cdot \left\{ a \cdot \gamma^b \cdot V^2 \cdot S_\kappa + E \cdot S_\kappa \cdot \exp \cdot \left[\int_1^2 k(l)dl \right] \cdot sign|V| \right\}, \qquad (3)$$

where *f* – coefficient of friction of filament on a filament; *a*– empiric coefficient which is related to the mechanism of coupling of fibers in a yarn at twisting in spinning production; *b*– empiric coefficient which is related to the mechanism of coupling of nap of two filaments to mobile textile kinematic pack; γ– density of contact of filament in a loop; *V*– relative speed of filament on a filament; S_k – area of contact of filament in a loop; *E*– module of resiliency of material of textile filament; *k (l)* – the curvature of filament in the area of contact, expressed through length of arc from l to l; *sign/V/*– sign –function, which determines the sign of the second addition, dependency upon the sign of speed.

Additionally in classification of TKP, as physical objects, it is possible to lay down that TKP is splays connection of structures of thread linear (strands of fibers on length, ribbons from the stitches of thread), flat (fabrics, knitted fabric) and spatial (linear and flat structures incorporated in good from textile materials). Examples of physical models of the system of the TKP one - line structure of TKP and 2D-structures are given on Fig.1.

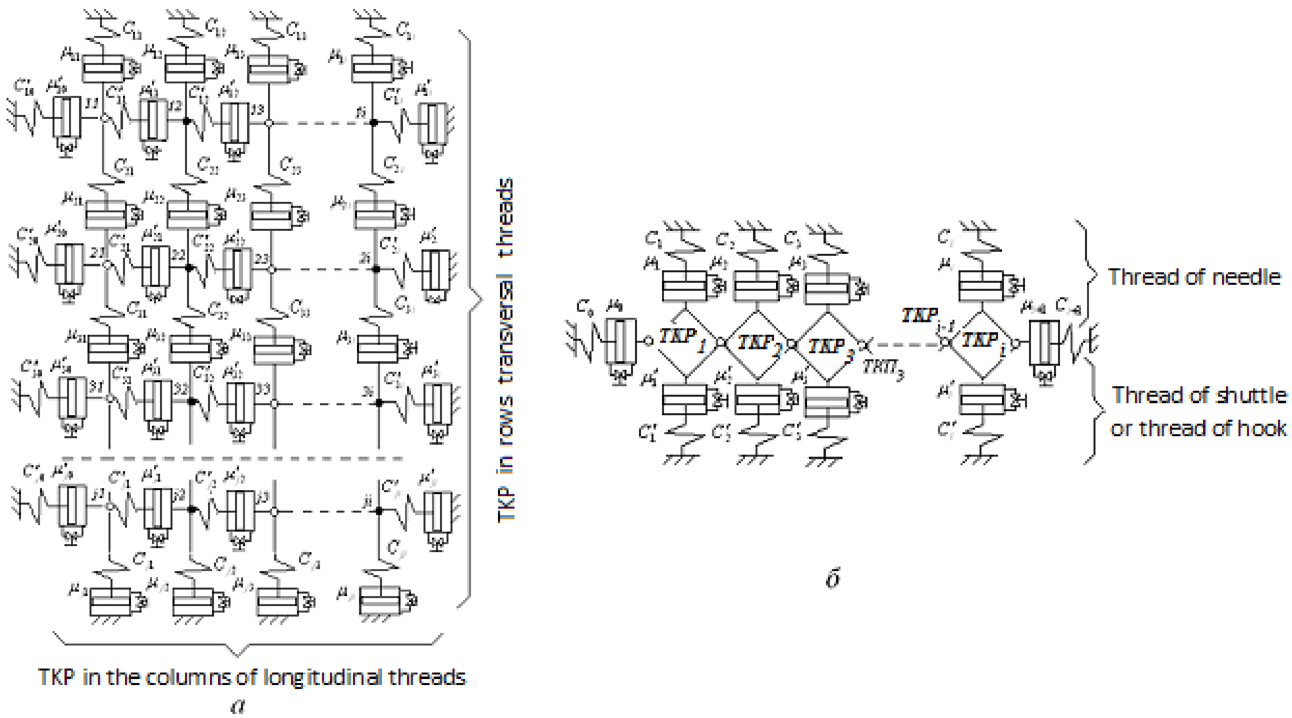

Fig. 4.**Examples of physical models of the system TKP: and – 2D-TKP on the example of fabric of the linen interlacing ; – structure of 2D-TKP on the example of shuttle by a line**

Association of physical models on Fig.1 forms a structure 3D-TKP.

For mathematical description of mechanism of formation of the TKP different structures, namely to the mechanism of accumulation and concentration of tensions in the area of contact in TKP formation the method of reverse identification is applied to the physical processes that take place in mechanisms of destruction of deformation bodies at a small – circle fatigue [16].

Conclusions

A new object (notion) «textile kinematic p.» is the generalized element of structures of a different technological origin of thread. Structural basis of TKP of two modifications and classification of 4 classes TKP are resulted. The new notion (physical object) «textile kinematic p.» is formulated and proved here.

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Обоснование текстильных кинематических пар как обобщённого элемента ниточных структур

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Приведена целесообразность и обоснование нового объекта (понятия) «*текстильные кинематические пары*» из нитей (пряжи) которые имеют плоскую или пространственную структуру из текстильных узлов разных переплетений и повторяются в рапорте текстильных материалов. Доказана общность существования текстильных кинематических пар в текстильных материалов разного происхождения, а именно: ниточных стежках, строчках и швах, которые производятся на швейных машинах, тканях, которыепроизводятся на ткацких станках, трикотаже, который вырабатывается на трикотажных и вязальных машинах, шнурах и канатов, который вырабатывается на шнуроплетельних и шнуровязальних машинах.

Ключевые слова:текстильные кинематические пары, пространственная структура, пряжа.

The ground of textiles kinematic pack as generalized element of thread structures

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Expedience of a new object (notion) «textiles kinematic pack» (TKP) is pointed. It is appeared from filaments (yarn) and has the structure of thread flat or spatial textile knots made from filaments. They are interlaced and repeated themselves in the report of textile materials. The generalized existence of textile kinematic packs at textile materials of a different origin is led to, namely: stitches, lines and seams. They are made on sewing machines; fabrics are made on looms, knitted fabrics - made on knitting machines; cords and ropes - made on interlacing and lace-knitting machines.

Keywords: textile kinematic pairs, spatial structure, yarn.