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RESEARCH OF EXTENSIBILITY OF RACKED STITCHES

Purpose. The purpose is to conduct the research of influence of knitting's technological parameters on the relaxation characteristics of racked stitches based on rib, half cardigan and full cardigan.

Methodology. Theoretical, analytical and experimental research methods are used in this work. The researches have been conducted by the procedure in accordance with the State Standard of Ukraine 3823-98 "Knitted fabrics. Norms and method of quality inspection".

Results. Influence of the number of racking of the needle bed on physical mechanical properties of racked stitches has been revealed. Mathematical regression equations to calculate the full deformation of racked stitches have been obtained depending on knitting's technological parameters.

Scientific novelty. It has been established that the number of racking of the needle bed is an important technological parameter that significantly affects the extensibility properties of racked stitches. Mathematical relationships of full deformation have been obtained depending on the number of racking of the needle bed, linear density of the yarn and sinking depth.

Practical value. Character of the influence of knitting parameters on a full deformation on width and length of racked stitches based on rib, half cardigan and full cardigan has been established. Technologic parameters of racked stitches for manufacturing of high quality knitted fabrics according to the extensibility characteristics has been recommended.

Keywords: weft knit, racked stitches, physical mechanical properties, extensibility of knitted fabrics, the number of racking of the needle bed.

Introduction. Modern technologies allow to change designs, patterns areas, interlooping and to manufacture a wide assortment of knitted goods on knitting equipment easily, without huge efforts and time spending.

The research and determination of the properties of knitted fabrics are important when designing competitive knitted goods. Racked stitches is interesting and promising in terms of the search for new artistic solutions for knitted fabrics and goods. It is important to know the properties of racked stitches based on rib, half cardigan and full cardigan for their further use [1, 2].

Objectives. Stretching properties of knitted goods is one of the main physical mechanical characteristics to assess the quality of knitted fabrics. Determination of the relaxation characteristics of textile fabrics in case of stretching is important to assess their shape stability and elastic properties.

Therefore, the influence of knitting's technological parameters on the relaxation characteristics of racked stitches based on rib, half cardigan and full cardigan is important for evaluation of the quality and prediction of the properties of knitted fabrics.

Results of research. Racked stitches is called double weft knit where its loops instead of being drawn through the preceding loops of their own wales are drawn through the loops of neighbouring wales and as a result, there is a crossing of loop carcasses. The kind of knit is produced by shifting the face loops of double weft knit in respect to the back loops over one and sometimes more loop spaces to one or the other side [3,4]. During the use, knitted goods receive significant load. To assess deformation properties of racked stitches, full deformation and its

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components have been established. Correlation of the components of full deformation indicates mechanical properties of the fabrics.

The research results of an extensibility of knitted goods with base stitches and racked stitches under loads less than breaking ones depending on the number of racking of the needle bed are presented in Table.

Table 1

Extensibility of racked stitches

Number of racking of the needle bed	deformation on lengthwise				deformation on widthwise			
	Full deformation, ε, %	Elastic, ε_1, %	Plastic, ε_2, %	Residual, ε_3, %	Full deformation, ε, %	Elastic, ε_1, %	Plastic, ε_2, %	Residual, ε_3, %
Racked stitches based on rib								
0	84	62	7	15	250	178	24	48
1	97	67	7	23	111	58	10	43
2	84	62	6	16	107	83	8	16
3	80	58	6	16	63	52	4	7
4	85	57	11	17	56	45	5	6
5	92	68	8	16	56	44	3	9
6	95	70	9	16	53	43	3	7
7	90	63	8	19	49	38	6	5
Racked stitches based on half cardigan								
0	107	82	15	10	153	107	25	21
1	135	83	28	24	83	60	9	14
2	97	72	12	13	72	54	10	8
3	93	63	12	18	68	48	11	9
4	72	55	9	8	55	43	6	6
5	82	57	10	15	58	42	10	6
6	92	62	13	17	54	40	8	6
7	91	61	13	17	52	37	9	6
Racked stitches based on full cardigan								
0	97	71	11	15	130	90	18	22
1	165	85	31	49	57	41	3	13
2	161	10	19	32	64	41	8	15
3	158	106	14	38	52	40	5	7
4	122	88	10	24	51	37	5	9
5	98	72	6	20	50	32	10	8
6	88	61	13	14	53	39	4	10
7	127	82	15	30	45	33	3	9

Full deformation ε is composed of: elastic deformation ε_1 that disappears immediately after stress relief in the testing sample, plastic deformation ε_2 with a long period of relaxation that develops over time with low speeds, residual deformation ε_3 that does not disappear after stress relief in the sample [5,6].

Experimental researches of racked stitches extensibility under loads less than breaking ones have been conducted in laboratory conditions on the relaxometer of "stand" type according to a

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standard procedure. Loads less than breaking ones have been applied to the fabrics - 6H according to the State Standard of Ukraine 3823-98 [7].

Analysis of the research results on full deformation of racked stitches based on rib, half cardigan and full cardigan depending on the number of racking of the needle bed compared to the base stitches has demonstrated that:

- full deformation of racked stitches based on rib widthwise is changed insignificantly, and lengthwise it is 2-5 times less than full deformation of base stitches;

- full deformation of racked stitches based on half cardigan widthwise and lengthwise based also significantly less than full deformation of base stitches;

- full deformation of racked stitches based on full cardigan widthwise is increased and full deformation of racked stitches based on full cardigan lengthwise is reduced significantly compared than full deformation of base stitches;

It is necessary to build the polynomial models for full deformation in the form of second order for more accurate mathematical description of the knitting process of racked stitches based on rib, half cardigan and full cardigan.

As a result of conducted researches the most important and influential input factors have been defined [8]. Therefore, we have confined to three technologic parameters - the number of racking of the needle bed, linear density of the yarn and sinking depth for conducting of multivariate experiment. Thus, as input factors we have taken:

- x_1 – the number of racking (number of racking of the needle bed have been defined by design features of the flat knitting machine, on which it is possible to make from 1 to 10 racking, as well as compliance of high quality process of loop formation when knitting basic interlooping, so the number of racking of the needle bed have been performed from 1 to 7);

- x_2 – linear density of the yarn (varying intervals are set so that the process of loop formation also take place under normal conditions, changing of the linear density has been made from 31 tex x 2 to 31 tex x 8);

- x_3 – sinking depth (it has been changed from 4.10 mm to 5.90 mm).

The experiment has been conducted according the second-order model for three factors in accordance with the central compositional rotatable design. The samples have been made of half-woolen yarn (40% - wool, 60% - nitron) on the flat bed knitting machine of 6 gauge class, the number of needles and the number of rows have remained unchanged. Draw-off of the fabrics and input yarn tension have been recorded on the same level and have remained unchanged.

The samples has been produced in accordance with the technical requirements. The adequate equations have been obtained with probability 0.95 with the help of the least squares procedure and statistical analysis [9,10]. Mathematical processing of the experimental results has been performed on ECM.

Taking into consideration the significance of the regression coefficients, the second-order mathematical models are presented to calculate the full deformation widthwise and lengthwise of racked stitches based on rib, half cardigan and full cardigan in coded values:

$$Y\{\varepsilon_r\}_w = 84,25 - 24,87 x_2 + 4,27 x_3 \tag{1}$$

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$$Y\{\varepsilon_{hc}\}_w = 78,45 - 6,37x_1 - 21,5x_2 + 9,53x_1^2 \tag{2}$$

$$Y\{\varepsilon_{fc}\}_w = 117,22 - 16,26x_1 - 25,33x_2 + 8,85x_1^2 \tag{3}$$

$$Y\{\varepsilon_r\}_l = 56,87 - 22x_1 - 8,91x_2 + 5,02x_3 + 6x_1x_2 + 9,95x_1^2 + 6,23x_2^2 \tag{4}$$

$$Y\{\varepsilon_{hc}\}_l = 56 - 12,98x_1 - 16,76x_2 + 6,61x_3 + 6,63x_1x_2 + 5,06x_1^2 + 4,7x_2^2 \tag{5}$$

$$Y\{\varepsilon_{fc}\}_l = 49,78 - 5,8x_1 - 9,16x_2 + 4,82x_3 + 5,88x_1x_2 \tag{6}$$

Analysis of the results of obtained mathematical regression of full deformation of racked stitches (1-6) has demonstrated that:

1. Change of the number of racking of the needle bed does not affect the full deformation widthwise of racked stitches based on rib;

2. The full deformation of racked stitches based on half cardigan and full cardigan widthwise is decreased when the number of racking of the needle bed is increased from 1 to 7:

- full deformation of racked stitches based on half cardigan widthwise is decreased at T min - by 14%, at T max – by 26% when while maintaining the sinking depth at the secondary level;

- full deformation of racked stitches based on full cardigan widthwise is decreased at T min - by 26%, at T max – by 26% when while maintaining the sinking depth at the secondary level;

- full deformation of racked stitches based on half cardigan widthwise is decreased by 18 % when while maintaining the linear density of the yarn at the secondary level;

- full deformation of racked stitches based on full cardigan widthwise is decreased by 32% while maintaining the linear density of the yarn at the secondary level;

3. The full deformation of racked stitches based on on rib, half cardigan and full cardigan lengthwise is decreased when the number of racking of the needle bed is increased from 1 to 7:

- full deformation of racked stitches based on rib lengthwise is decreased at T min - by 63%, at T max – by 37% when while maintaining the sinking depth at the secondary level;

- full deformation of racked stitches based on half cardigan lengthwise is decreased at T min - by 53%, at T max – by 12% when while maintaining the sinking depth at the secondary level;

- full deformation of racked stitches based on full cardigan lengthwise is decreased at T min - by 58%, at T max – by 32% when while maintaining the sinking depth at the secondary level.

- full deformation of racked stitches based on rib lengthwise is decreased at $H_к$ min - by 65%, at $H_к$ max – by 57% when while maintaining the linear density of the yarn at the secondary level;

- full deformation of racked stitches based on full cardigan lengthwise is decreased at $H_к$ min - by 54%, at $H_к$ max – by 42% while maintaining the linear density of the yarn at the secondary level;

- full deformation of racked stitches based on half cardigan lengthwise is decreased at $H_к$ min - by 37%, at $H_к$ max – by 29% when while maintaining the linear density of the yarn at the secondary level;

It has been determined that racked stitches based on rib, half cardigan and full cardigan refers to the fabrics of I group of extensibility when the number of racking of the needle bed is more

than 1. Racked stitches have less spring properties compare to the fabrics base stitches. This contributes to better performance and shape stability properties of racked stitches based on rib, half cardigan and full cardigan compared to base stitches.

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ДОСЛІДЖЕННЯ РОЗТЯЖНОСТІ ТРИКОТАЖУ ПЕРЕХРЕСНИХ ПЕРЕПЛЕТЕНЬ

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Мета. *Дослідження впливу технологічних параметрів в'язання на релаксаційні характеристики трикотажу перехресних переплетень на базі ластику, напівфангу та фангу.*

Методика. *У роботі застосовані теоретичні, аналітичні та експериментальні методи досліджень. Дослідження проводилися за методикою згідно зі стандартом ДСТУ 3823-98 «Полотна трикотажні. Норми та метод оцінки якості».*

Результати. *Виявлено вплив кількості зсувів голечниці на фізико-механічні властивості трикотажу перехресних переплетень. Отримано математичні рівняння регресії для розрахунку повної деформації трикотажу перехресних переплетень на базі ластику, напівфангу й фангу у залежності від технологічних параметрів в'язання.*

Наукова новизна. *Встановлено, що кількість зсувів голечниці є важливим технологічним параметром, який значно впливає на розтяжність трикотажу перехресних переплетень. Отримано математичні залежності повної деформації у залежності від кількості зсувів голечниці, лінійної густини пряжі та глибини кулірування.*

Практична значимість. *Встановлено характер впливу параметрів в'язання на повну деформацію по ширині й довжині трикотажу перехресних переплетень на базі ластику, напівфангу й фангу. Рекомендовано заправки трикотажу перехресних переплетень для виготовлення якісних трикотажних полотен згідно паказникам розтяжності.*

Ключові слова: *кулірний трикотаж, трикотаж перехресних переплетень, фізико-механічні властивості, розтяжність трикотажу, кількість зсувів голечниці.*

ИССЛЕДОВАНИЕ РАСТЯЖИМОСТИ ТРИКОТАЖА ПЕРЕКРЁСТНЫХ ПЕРЕПЛЕТЕНИЙ

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Цель. *Исследование влияния технологических параметров вязания на релаксационные характеристики трикотажа перекресных переплетений на базе ластика, полуфангу и фанга.*

Методика. *В работе применены теоретические, аналитические и экспериментальные методы исследований. Исследования проводились по методике согласно стандарту ДСТУ 3823-98 «Полотна. Нормы и метод оценки качества».*

Результаты. *Выявлено влияние количества сдвигов игольницы на физико-механические свойства трикотажа перекрёстных переплетений. Получены математические уравнения регрессии для расчета полной деформации трикотажа перекрёстных переплетений на базе ластика, полуфанга и фанга в зависимости от технологических параметров вязания.*

Научная новизна. *Установлено, что количество сдвигов игольницы является важным технологическим параметром, который значительно влияет на растяжимость трикотажа перекрестных переплетений. Получены математические зависимости полной деформации в зависимости от количества сдвигов игольницы, линейной плотности пряжи и глубины кулирования.*

Практическая значимость. *Установлен характер влияния параметров вязания на полную деформацию по ширине и длине трикотажа перекрестных переплетений на базе ластика, полуфанга и фанга. Рекомендовано заправки трикотажа перекрестных переплетений для изготовления качественных трикотажных полотен согласно показателям растяжимости.*

Ключевые слова: *кулирный трикотаж, трикотаж перекрёстных переплетений, физико-механические свойства, растяжимость трикотажа, количество сдвигов игольницы.*