Study of the mechanical properties of knitted fabrics

Dilora Ubaydullaeva[1*], *Shamsiya* Shumkarova[2], *Mohinur* Akhmedova[1], *Rustam* Begmanov[3]

[1]Tashkent Institute of Textile and Light Industry, Tashkent, Uzbekistan
[2]Jizzakh Polytechnic Institute, Jizzakh, Uzbekistan
[3]Institute of Mechanics and Seismic Stability of Structures Named After M.T.Urazbaev, Academy of Sciences of the Republic of Uzbekistan, Tashkent, Uzbekistan

Abstract. In this article results of analyses physical-mechanical properties of 3 new structures of fleecy knitting interloping made by cotton yarn of different linear density at the flat knitting machine TERROT have been offered. The influence of the location of the lining thread on the physical and mechanical properties of the lining knitted fabric in the composition of the newly formed, it turned out the place of their use can be determined by the type of raw material.

1. Introduction

The knitwear industry is currently one of the most important sub-sectors of the textile industry. One of the main and most time-consuming ways to expand the range of knitted fabrics is the development of a knitted fabric with a new structure, formed by the targeted use of the product, providing new characteristics or high-quality indicators.

The development of knitwear production is due to the increasing demand for knitwear every day. An important indicator of the quality of knitwear for outerwear is its dimensional stability, which is usually understood as the ability of knitwear to restore its original shape in the process of relaxation after deformation. Among the knitted fabrics that are successfully used in the manufacture of outerwear, warm underwear, children's products, as well as technical products, lining fabrics with improved heat-shielding properties are of particular interest.

From an economic point of view, knitting knitwear is expedient, since with the same consumption of raw materials, knitwear has a greater thickness than knitwear of other types, and, therefore, has improved heat-shielding properties. In addition, the structure of the footer jersey allows the use of combinations of threads of different types, and therefore different in cost, without compromising the quality of the product [1].

One of the ways to expand the range and improve the quality of manufactured knitwear is the development of new structures and methods for producing footer knitwear with improved quality indicators.

The footer knitted fabric is widely used for underwear, tracksuits, children's products, as well as coats, collars, carpets, furniture, shoes, and especially for outerwear with high heat-shielding properties [2].

Taking into account the increasing number of types of liner knitwear and methods of their production, a number of scientists have created a classification of cross single-layer lined knitwear. They adopted a separate characteristic, the appearance of the fabric, that is, the base fabric selected for the production of the base fabric, and the method of attaching the warp thread to the warp, in dividing the base fabric into different groups.

The authors [3] fully substantiated the recommendation for the distribution of footer knitwear according to the above characteristics. The recommended classification covers all the main characteristics and factors from knitting fur knitwear to the moment it is turned into a product.

In order to meet the needs of the population in warm clothes, methods for obtaining knitted fabrics with a high pattern efficiency based on fur knitwear were studied, and on their basis a three-stage process for obtaining a two-layer fur knitwear was developed. fabric was created [4].

In order to expand the range of outer knitwear and improve their quality, improve shape retention, expand the scope of their appearance, it is recommended to obtain a fabric with a one-sided footer based on synthetic thread [5], press [6], jacquard [7] and linen [8].

*Corresponding author: dilora.ubaydullayeva@mail.ru

 https://doi.org/10.1051/e3sconf/202343403033

2. Methodology

A number of studies have been studied [9-14], conducted with the aim of increasing the types of footer knitwear, increasing the shape-stable properties and reducing the consumption of raw materials.
Fleecy knit fabric samples are given in Figures 1 and 2.

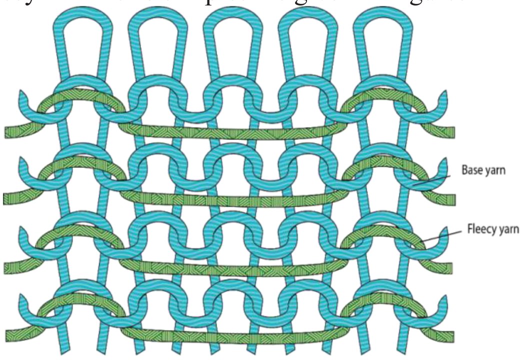

Fig.1. Fleecy knitting structure 3/1, s = 0

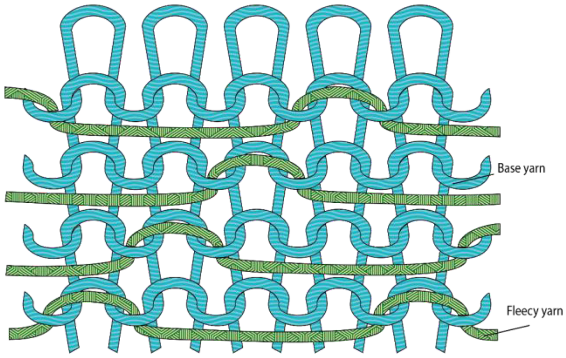

Fig.2. Fleecy knitting structure 3/1, s = 1

Table 1. Technological parameters of knitted fabrics of different rapports

Variants	Linear density of yarn, teks	Loop width, A, mm	Loop course height, B, mm	Thread length in the loop, mm		Surface density, g/m^2	Thicknes, mm	Volume density, g/m^3
				ground	fleecy			
1 variant	cotton T=20 polyester 75 Den	1,09	0,65	4,88	1,83	329,4	1,1	299,45
2 variant	cotton T=20 Viscose30 Den	0,69	0,46	3,07	1,01	262,5	1,1	238,63
3 variant	cotton T=20	0,71	0,59	3,05	1,03	175,2	0,4	438

Technological parameters such as loop width A (mm), loop course height B (mm), loop length l (mm), surface density g / m^2, thickness mm, volume density g / m^3 were determined experimentally and included in Table 1.

3. Results

When the results are analyzed, one of the technological parameters of fleecy knitted fabric, the loop width varied in the range of 0.69–1.09 mm (36%) (Fig. 3). The loop course height appears to vary from 0.46–0.65 mm in the fleecy fabric variants (Fig. 4).

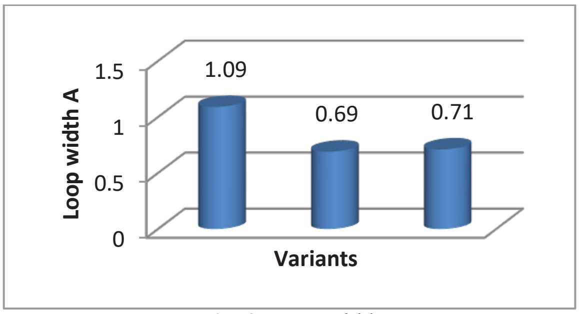

Fig. 3. Loop width

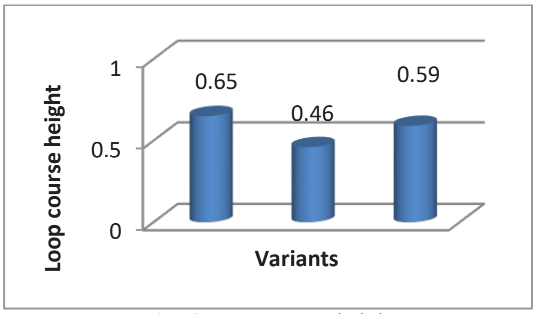

Fig. 4. Loop course height

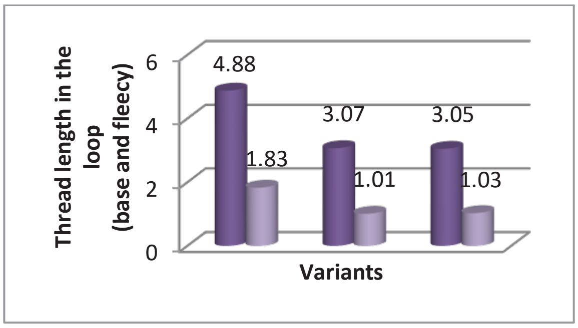

Fig. 5. Thread length in the loop

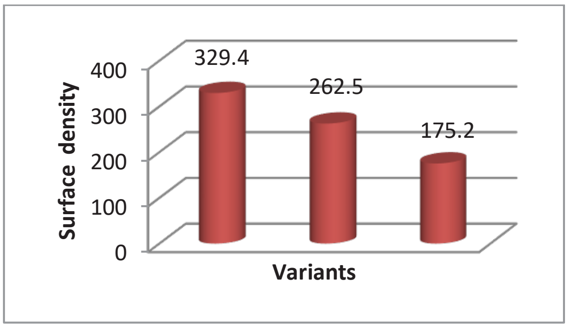

Fig. 6. Surface density

The parameters of the length of the loop thread in the fabric are as follows: according to the analysis of fleecy knitwear rapport, the length of the loop thread is 3.05-4.88 mm (37.5%) change in the base thread and 1.01-1.83 mm in the liner thread (44 , 8%) change is observed (Fig. 5).

The surface density analysis of the fabrics shows that the surface density of the fleecy knitted fabric samples is 175.2–329.4 g / m2, a change of 46.8% for the fleecy knitted samples (Fig. 6).

The results of the analysis show that the volume density ranged from 238.63 to 438, which is 45% difference between maximum and minimum. A 46.8% change in surface density resulted in a 45% change in volume density. While surface density takes into account the width and height of the knitting, volume density is a parameter that takes into account the thickness as well as the width and height of the knitting. Therefore, a decrease in volume density indicates a decrease in raw material expenditure (Fig. 7).

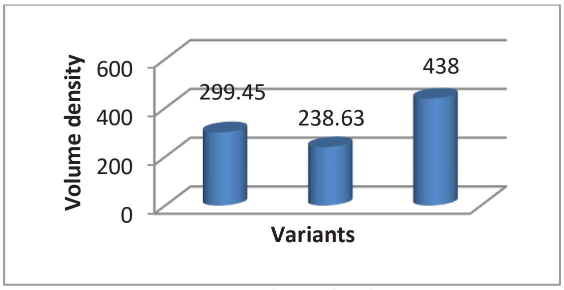

Fig. 7. Volume density

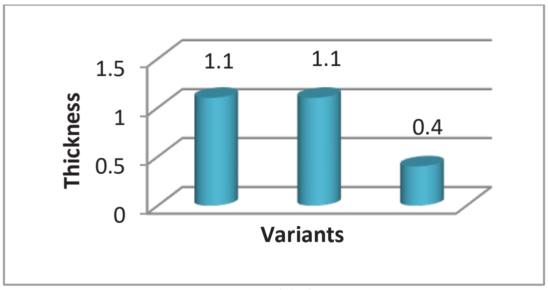

Fig. 8. Thickness

The next parameter is the thickness of the knitting. In order to further define the raw material used in the fabric of knitted fabric, its thickness must also be taken into account. The thickness of the samples can also be determined under a special thickness measuring instrument under laboratory conditions. The thickness of the knitting according to the variants is 0.4-1.1 mm and it is observed that it varies up to 63.6%. Since the surface density is directly related to the expenditure of raw materials and the volume density is related to the thickness of the knitting, it is correct to estimate by this parameter (Fig. 8).

3.1 Phisical-mechanical properties of fleecy knitted fabrics of different rapports

The physical and mechanical properties of the newly created tissues were experimentally analyzed using modern equipment installed in the certification laboratory "CENTEXUZ" under TITLI. Research was conducted to determine properties such as air permeability, friction resistance, tensile strength, elongation at break, elongation (at 6 N), deformation, tensile strength. All results were tabulated.

Table 2. Phisical-mechanical properties of fleecy knitted fabrics of different rapports

Variants	Friction resistance, cycle	Break strength, N		Break elongation, %		Air permeability, $Sm^3/sm^2 s$
		length	width	length	width	
1 variant	24100	265	224	74,8	111	74,8
2 variant	25000	264	142,6	39,3	162,3	39,3
3 variant	17600	230,3	106	152	312	152

Analyzing the values given in Table 3 of the samples obtained, the friction resistance ranged from 17,600 to 25,000. In Fleecy knitwear, this figure varies in the range of 29.6%, which in turn provides information about the durability and service life of the knitted fabric. The highest value for friction resistance is in option 2, which is recommended for use in areas with high friction (Fig. 9).
If the values of the obtained samples are analyzed, the tensile strength in length and width during the study is given in the following diagram for fleecy knitted fabric (Fig. 10). The longitudinal tensile strength is 230.3-265 N, while the transverse tensile strength is 106-224 N. It varies in height by 13% and width by 52.7%. The shear strength performance of the variants is relatively stable.

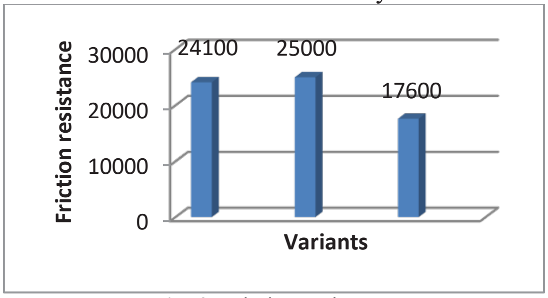

Fig. 9. Friction resistance

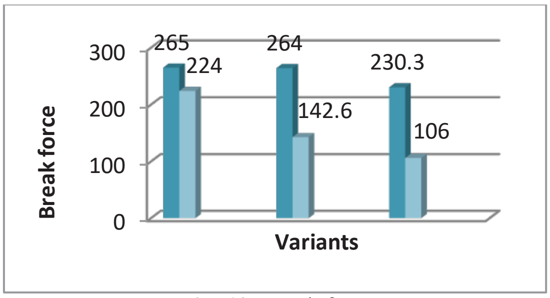

Fig. 10. Break force

The shear rates across the width vary widely, mainly due to the fact that the fleecy yarns are arranged differently depending on the rapport in the fabric composition. However, the options are produced using raw materials of different compositions. Option 1, which has the highest shear strength, can be recommended as the option with the highest width strength.
The results of the elongation study show that elongation was 72.3–175.6% in height and 111–312% in width compared to fleecy knitted fabric. It varies in height from 58.8% to width from 64.4% (fig.11).
The lower the elongation index, the higher the shape-retaining property of the knitwear. As a sample with the highest shape retention feature, 3 options and 1 width option can be recommended.

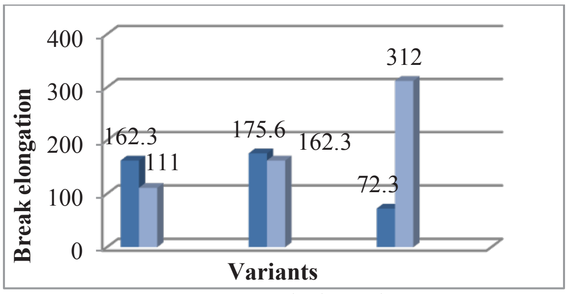

Fig. 11. Break elongation

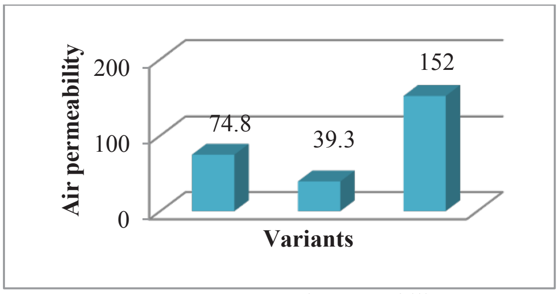

Fig. 12. Air permeability

According to the results of the study, when the samples are compared with each other, Variant 3 has a high index of air permeability, and this variant can be recommended for assortments that require high values of air permeability (Fig. 12).

Table 3. Deformation property of fleecy knitted fabrics of different rapports

Variants	Tensility (on 6N)		Flexible deformation		Elastic deformation		Plastic deformation	
	length	width	length	width	length	width	length	width
1 variant	3,67	2,97	35,6	38	5,6	7	9	8,6
2 variant	3,99	6,83	53	35	3,6	2,6	3,3	3
3 variant	1,88	17,66	22,3	26,3	3,6	4,6	4,6	5,3

If the elongation results are analyzed, the elongation at length was 1.88–3.99% compared to that for fleecy knitted fabric, and the elongation at width was 2.97–17.66%. The change in elongation is 53% and the change in width is 83% (Fig. 13).
It should be noted that such knitted fabrics are suitable for assortments of outerwear, sportswear and children's clothing. Based on the analysis of stretch and elongation (6N) results, it was found that knitwear has a high shape retention property, and this fabric is recommended for the production of children's, women's, men's top knitwear.

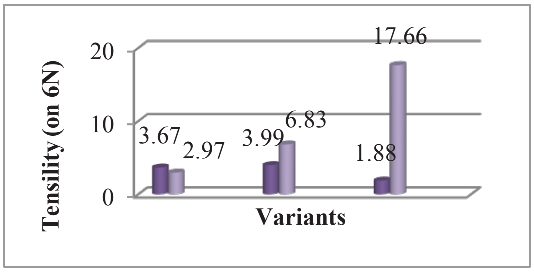

Fig. 13. Tensility (on 6N)

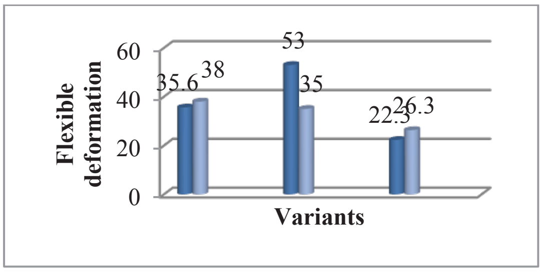

Fig. 14. Flexible deformation

According to the results of the study, when the samples were compared with each other, the longitudinal deformation was 22.3-53% and the width back deformation was 26.3-38%. The change in elongation is 58% and the change in width is 31% (Fig.14).

In this case, the deformation values along the neck vary in a slightly larger range, as a result of which the deformation values along the length of the tissue do not reach a stable state. If the deformation values of the width of the tissue samples are analyzed, then the values of the elastic deformation width are more stable, and the additional fleecy rings included in the tissue structure allow it to occupy a state of equilibrium along the rows of rings.

As a result of the analysis of the deformation parameters, options 1 and 3 can be recommended as a slightly higher option in length and width of the deformation property.

According to the results of the study, when the samples are compared with each other, the elastic deformation of the neck is 3.6-5.6%, the elastic deformation of the width is 2.6-7%. The change in elongation is 35% and the change in width is 63% (Fig. 15).

In this case, the width of the elastic deformation index varies in a slightly larger range, as a result of which the deformation index of the width of the tissue does not reach a stable state.

If the elastic deformation indices relative to the width of the tissue specimens are analyzed, then option 2 is recommended as the option with the lowest value in terms of the elastic deformation indices, with additional fleecy rings included in the tissue composition allowing it to assume equilibrium along the ring rows.

As a result of the analysis of elastic deformation parameters, options 2 and 3 can be recommended as somewhat acceptable options for the length and width of the deformation property.

According to the results of the study, when the samples are compared with each other, the plastic deformation of the neck is 3.3-9%, the plastic deformation of the width is 3-8.6%. The change in elongation is 63% and the change in width is 70% (Fig. 16).

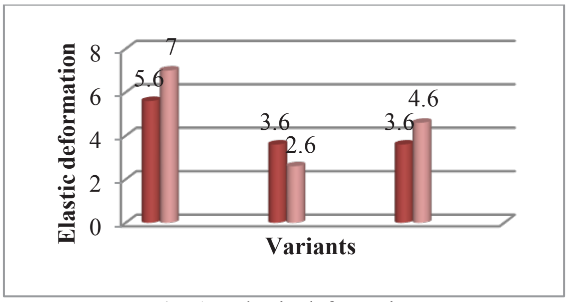

Fig. 15. Elastic deformation

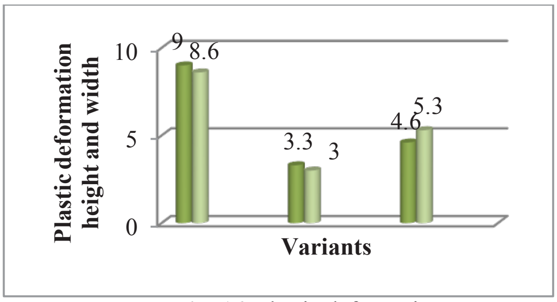

Fig. 16. Plastic deformation

If the elastic deformation indices relative to the width of the tissue specimens are analyzed, then option 2 is recommended as the option with the lowest value in terms of the elastic deformation indices, with additional fleecy rings included in the tissue composition allowing it to assume equilibrium along the ring rows.

As a result of the analysis of plastic deformation parameters, all options can be recommended as somewhat acceptable option for the length and width of the deformation property.

There are several methods of assessing the quality of textile products: expert assessment, sociological assessment, organoleptic assessment and complex assessment. In the complex evaluation method, a polygonal surface is formed by dividing several quality indicators such as air permeability, surface density, volume density, breaking force on length and width, breaking elongation on length and width, thickness of products along horizontal and vertical lines. Options on the polygon surface are evaluated.

4. Conclusions

According to the results of the analysis of the influence of the location of the lining thread on the physical and mechanical properties of the lining knitted fabric in the composition of the newly formed, it turned out the place of their use can be determined by the type of raw material.

One of the main and most time-consuming ways to expand the range of knitted is the development of a knitted fabric with a new structure, formed dy the targeted use of the product, providing new characteristics or high-quality indicators.

References

1. Yu.S. Shustov, Textile materials, INFRA-M, Moscow (2016)
2. Z.F. Valieva, A.A. Akhmedov, T.A. Ochilov, D.X. Ubaydullayeva, Sh.A. Korabayev, Possibility to Use Acoustic Device Pam-1 to Determine Quality Characteristics of Wool Fiber, *Annals of R.S.C.B.* **25**(6), 10166–10173 (2021)
3. T. Chanda, M. Ahirwar, B.K. Behera, Appraisal of Bed Linen Performance with Respect to Sleep Quality, *Textile Leather & Review* **3**, 19-29 (2020)
4. R. Sudhakar, G. Renjini, Evaluation and prediction of fused fabric composites properties – A review, *Journal of Industrial Textiles* **51**, 3536S-3574S (2022)
5. M.S. Hoque, M.J. Hossain, M.M. Rahman, M.M. Rashid, Fiber types and fabric structures influence on weft knitted fabrics, *Heliyon* **8**(6), e09605 (2022)
6. M.M. Mukimov, A.E. Isaboev, D.Kh. Ubaydullaeva, Study of the influence of the double-sided weave structure on the parameters of press jersey, *Textile Problems* **2**, 102-103 (2005)
7. D.H. Ubaydullayeva, A. Toyirova, Tursunoy, D.A Xalmatov, M.T. Yuldasheva, A.V Axmadbekova, Change Efficiency of Cleaning Cotton from Small and Large Pollutions, *Int J Advanced Research in Science, Engineering and Technology* **7**, 9 (2020)
8. J.R. Mukhtarov, M.R. Atanafasov, Z.F. Valieva, M.B. Djumaniyazov, E.T. Laysheva, The effect of the amount of waste of yarn on the physical and mechanical indicators, *European Chemical Bulletin* **11**(6), 15-19 (2022)
9. A. Akhmedov, Z.F. Valieva, S.F. Makhkamova, S.U. Patxullayev, J.R. Mukhtarov, Influence of sample mass on accuracy of wool fiber tone measurement on an acoustic device, *Eur. Chem. Bull.* **11**(3), 34-38 (2022)
10. Z Utashov et al., Study on the effect of cotton fiber temperature on cleaning effects, *IOP Conf. Ser.: Earth Environ. Sci.* **1142**, 012087 (2023)
11. Ruvini W. Mathangadeera, Eric F. Hequet, Brendan Kelly, Jane K. Dever, Carol M. Kelly, Importance of cotton fiber elongation in fiber processing, *Industrial Crops and Products* **147**, 112217 (2020)
12. M. Kulmetov, J.R. Mukhtarov, Influence position of fibers on the quality of production In the processes of yarn production, *European Science Review* **2**, 240-244 (2018)
13. S. Johnson, D. Echeverria, R. Venditti, H. Jameel, Y. Yao, Supply Chain of Waste Cotton Recycling and Reuse: A Review, *AATCC Journal of Research* **7**, 19-31 (2020)
14. D.H. Ubaydullayeva, S.U. Patkhullaev, T.A. Ochilov, A.A. Abdugaffarov, Z. Valieva, Change of the Mechanical Properties of Fibers Produced From Bark of Mulberry Trees, *Int J Advanced Research in Science, Engineering and Technology* **7**, 1 (2020)