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Study of Elastic Warp Knitted Bands: Production and Properties

Študija elastičnih snutkovnih pletenih trakov: izdelava in lastnosti

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Abstract

Elastic fitted goods are identified as a separate group of medical textiles. This group includes elastic bandages, abdominal binders, posture correctors, corsets, recliners, etc. Elastic knitted bands are widely used in rehabilitation and prophylactic goods. This research studied the properties of elastic warp knitted bands that were made on an 18E gauge crochet machine. In order to reduce the product weight and to increase its comfort, a partial set (2-in/1-out) of elastomeric threads is used. This yarn is the main component of elastic fabric that affects stretch properties and end-use. In the warp knitted band, the polyurethane thread is usually used as longitudinal inlay yarn, which is located between the loop's overlap and underlap. In order to study the effect of polyurethane pre-elongation before knitting on band properties, seven pairs of gears were used and elongation was varied from 280% to 395%. The weft filling yarn connects the separate wales into the band. To prevent contact between polyurethane threads and the human body, the weft yarns were laid on both sides of the inlay yarn. The movements of weft guides were in opposite directions. In order to study the effect of weft yarn diameter on cover factor and bands properties, 2 ends, 4 ends or 6 ends of 16.7 tex polyester yarn were used to achieve corresponding overall linear densities of 33.4 tex, 66.8 tex and 100.2 tex. It was concluded that the partial drawing-in of the guide bar with polyurethane thread facilitated a reduction of up to 20% in the basis weight of the elastic band, while ensuring sufficient stretch properties. The impact of technological factors on the structural parameters and properties of the elastic band was established.

Keywords: elastic fabric, warp knitted band, elastomeric thread, stretch properties, guide bar drawing-in

Izvleček

Elastični izdelki so opredeljeni kot posebna skupina medicinskih tekstilij, v katero spadajo elastični povoji, trebušni pasovi, pasovi za pravilno držo, stezniki, počivalniki itd. Elastični pleteni trakovi se pogosto uporabljajo v izdelkih za rehabilitacijo in preventivo. V raziskavi so bile preučevane lastnosti elastičnih snutkovno pletenih trakov, izdelanih na kvačkalniku delitve 18E. Da bi zmanjšali maso izdelka in povečali njegovo udobje, je bil uporabljen delni vdev elastomernih osnovnih niti 2-vdeti/1-nevdeta osnovna nit). Elastomerna preja je bila glavni sestavni del elastičnega pletiva, ki vpliva na njegovo raztegljivost in končno rabo. V snutkovnem pletenem traku je poliuretanska preja običajno vzdolžno položena v zanko, nastalo med polaganjem niti na iglo in pod iglo. Za preučitev učinka predraztezka poliuretanske preje pred pletenjem na lastnosti traku je bilo uporabljenih sedem parov zobnikov, pri čemer se je raztezek spreminjal od 280 % do 395 %. Vložena votkovna preja je povezala ločene stolpce v trak. Da bi preprečili stik poliuretanskih niti s človeškim telesom, so bile votkovne preje vpletene na obeh straneh osnovne preje, položene v zanke. Polagalniki votkov so se gibali v nasprotnih smereh. Vpliv

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premera votkovne preje na faktor kritja in lastnosti trakov je bil preučen z združevanjem 2, 4 ali 6 poliestrskih prej dolžinske mase 16,7 tex, s čimer so bile dosežene skupne dolžinske mase 33,4 tex, 66,8 tex in 100,2 tex. Ugotovljeno je bilo, da delno zatezanje poliuretanskih prej, vdetih v polagalnike, omogoča do 20-odstotno zmanjšanje osnovne mase elastičnega traku, hkrati pa zagotavlja zadostno raztegljivost. Ugotovljen je bil vpliv tehnoloških dejavnikov na strukturne parametre in lastnosti elastičnega traku.

Ključne besede: elastično pletivo, snutkovno pleteni trak, elastomerna nit, raztezne lastnosti, zatezanje niti v polagalnikih

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1 Introduction

Compression garments are designed to provide fixed pressure to the human body. Such products are effective functional means in both therapy and the prevention of a number of diseases: varicose veins, the consequences of burns, post-surgery and post-traumatic edema, etc [1]. There are a number of requirements for compression garments and for materials for their production [2]. The two main requirements are: the stability of the product and the specified level of compression during use, as well as the guarantee of the product's comfort for consumers for the duration of use.

The necessary pressure on the human body is provided by fabric properties such as stretchability and elasticity, and by the product's construction: size and shape [3]. The elasticity of a knitted fabric is ensured by the incorporation of elastomeric thread [4] or core-spun yarn with elastane core into the knitted structure as the filling yarn that is laid in the stretching direction [5]. High residual deformation and a significant change in linear dimensions after washing affect a product's size and the fabric structure. This also negatively affects the compression properties of products.

Elastic material contours to the human body and accumulates residual deformation in the most curved parts when a compression garment is used. Thus, unlike static loading, there is an increase in the part of residual deformations in certain areas of compression clothing and a change in the fabric structure with a corresponding increase in the stretchability of the material. This leads to a change in the properties and the deterioration of the product's appearance. The main factor in the changing shape and size of clothing, including compression garments, is thus the accumulation of cyclic residual deformation, as well as a change in the stitch density due to a change in the fabric thickness [6].

Scientists around the world are studying the structural parameters [7, 8] and properties [9] of elastic knitted fabric, in particular mechanical characteristics such as deformations [10], stretchability [11] and elasticity [12]. This indicate great interest in the problem and its relevance. The results of such studies can be used in the development and manufacture of new materials with improved properties [13].

When manufacturing clothes from elastic materials that fit tightly to the body, patterns are usually made smaller than ones from ordinary materials. At the same time, there is an important requirement to maintain conditions for normal blood circulation and other physiological processes in the human body. The maximum permissible pressure on the human body should not exceed 1330–2000 Pa [6]. At the section where clothes are tightly fitted to the body, the pressure level is directly proportional to the stress (σ) in the stretched fabric and inversely proportional to the radius of cross-section curvature (R) [14]. Thus, under the same load, the pressure of the fabrics with different elongation is different [15].

Garment pressure on the human body depends on the stresses that arise during fabric stretching. Thus, the study of the pressure of elastic fabric revealed its dependence on the knitting parameters and conditions of the product's use [16]. As a result of the two-factor experiment, it was determined that fabric pressure on the human body depends on the pre-elongation of the elastomer filament, and on the fabric elongation and surface curvature. Another study [17] attempted to investigate the influence of the inlay-yarn insertion density into a knitted structure and the area of a rigid element integrated into a knitted orthopaedic support on a compression generated by that support. It was concluded that the lower inlay-yarn insertion density and its total amount can be used for orthopaedic supports of lower compression class.

The design of compression products is usually based on an analysis of the experimental dependence of the distributed load (or voltage) on the relative deformation obtained, usually, at a constant rate of the deformation (stretching diagrams) [13]. Therefore, the majority of studies on elastic materials involve the determination of their deformation properties using stretching diagrams, and using tests based on the load-unloading-relaxation cycle. An indirect approach for measuring pressure from a set of compression bandages and hosiery was developed by Cassandra Kwon et al. [18], from which rigidity (EI) values were determined, and tension–elongation curves and pressure-elongation data were calculated. The calculated pressure values were compared with PicoPress sensor readings measured on 10 participants. Results showed that the correlation between both approaches varied among bandage and hosiery samples.

However, during the use of compression products, the pressure on the body is not constant and decreases gradually to some equilibrium value. The authors [19] predicted the deformation properties of knitted fabric on the basis of a generalised Maxwell model. It was characterised by two average terms of relaxation and allowed the stress relaxation processes to be reliably simulated. Moreover, it allowed the dependence of the equilibrium stress component on the deformation to be predicted. The proposed method only needs the stress relaxation curve, which significantly reduces the test time. Ferdinand Tamoue et al. [20] concluded that the prediction of an applied pressure according to the modified Young-Laplace equation is realistic for both cotton-based and elastomer-based bandages. The main new findings were the utilisation of the specimen's stretched length for the prediction of the interface pressure in the modified equation, in contrast to the equation commonly found in literature, which uses the circumference of a randomly picked human subject's ankle to predict the pressure.

From the above-mentioned literature, the deformation properties of elastic textile materials are mostly determined on the one-cycle study by loading-unloading-relaxation [21]. As a result, the full deformation of the fabric and its components can be obtained, as well as the contents of elastic, plastic and residual deformations. There are several methods for determining the deformation characteristics of textile materials, which differ by the duration and conditions of the studies. The analysis of test methods of stretch properties of elastic fabric [22] allowed us to formulate recommendations on the efficiency of each.

The comfort characteristics of fabrics (particularly thermal insulation and permeability properties) are closely associated with changes in their structural parameters [23–26]. The evaluation of the air permeability of knitted fabrics containing elastane fibre applies both the standard method and a new approach based on fabric thickness measurement at different pressures [27]. Test results have shown that the air permeability of textile depends on their structure, fibre composition and porosity evaluated with regards to fabric thickness difference measured at different pressures [28]. The compressive behaviour of knitted elastic fabric affects excellence in comfort. It was found [29] that the stitch density (loop size) has a significant effect on the compressive load.

On the other hand, almost all research work examines elastic weft knitted fabrics, while only a few of them present study results of warp knitted fabric. The crocheting technique is widely used for elastic band production, but it is not sufficiently represented in scientific literature. Knitted fabric with elastomeric thread in each wale is usually used for rehabilitation products. It provides a high level of elasticity of the material and increases its density at the same time. The permeability of elastic knitted fabric can be increased by reducing the number of elastomeric yarns in its structure by not laying it in every course of weft knit and in every wale of a warp knit. However, this can lead to a decrease in elasticity and resilience. Thus, the purpose of this work was to study the structure and properties of elastic warp knitted bands with the partial threading of the guide bar by elastomeric threads.

2 Materials and methods

2.1 Sample production

All samples were produced on an 18E gauge LB-5000A crochet knitting machine made by Taiwan Giu Chun Ind. Co. Ltd. It was equipped with a heddle bar and 3-roller feeder for elastic threads or rubber.

The pillar stitch with closed loops (G1) from 16.7 tex polyester yarn was the ground interlooping of the studied fabrics (Figure 1). An elastomeric thread with a diameter of 0.8 mm was introduced into the knit structure as a longitudinal inlay yarn (G3). In order to reduce the product weight and to increase its permeability, the elastomeric filaments were drawn according to the repeat: 2 in + 1 out, while 16.7 tex polyester yarn was also used as weft inlay yarn (G2 and G4). It was laid on both sides of fabric to ensure the connection of chains in the fabric and to cover the elastomer. To determine the effect of the weft in laid yarn thickness on the properties of the fabric and reliable covering of the elastomeric filament in the structure, 2 ends, 4 ends or 6 ends of the polyester yarn were used to achieve the resultant 33.4 tex, 66.8 tex and 100.2 tex weft yarn respectively (X1).

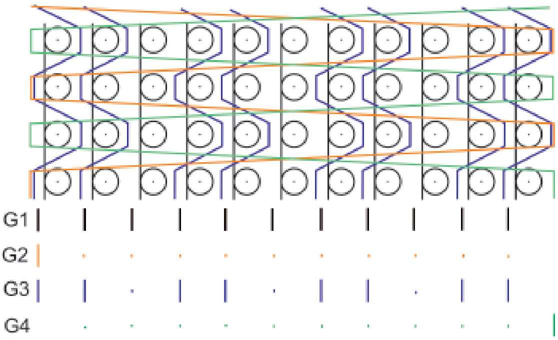
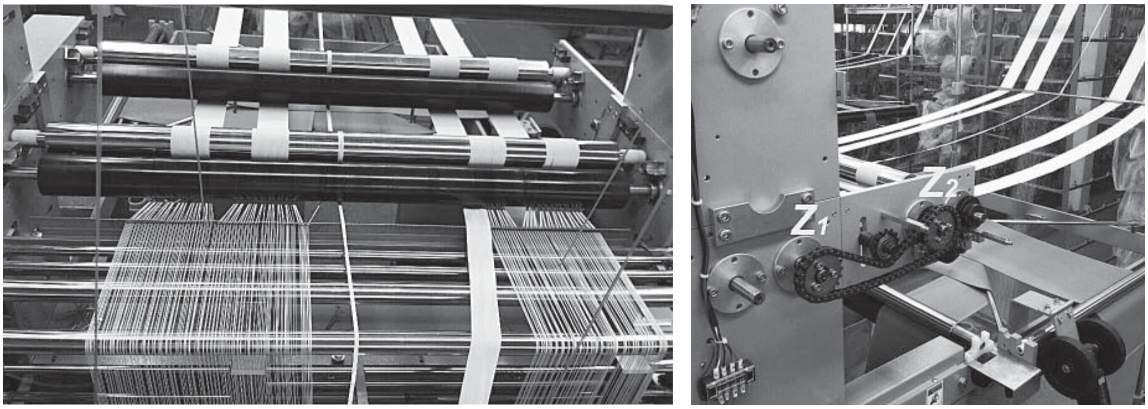


Figure 1: Lapping diagram

The parameters of the knitted structure and properties of the knitted fabric with elastomeric threads typically depend on its content. The elastomeric content can be limited by both the laying repeat and the degree of pre-elongation before entering the knitting zone [11, 30]. The preliminary elongation of the elastomeric filaments on the crochet machine is ensured by the ratio of the speed of the shafts' rotation in the feeding zone (Figure 2). In this study, it was varied by the number of gear teeth: leading z_1 – 27, 29, 31 and driven z_2 – 21, 23, 25, resulting in seven levels of the pre-elongation (X2) of the elastomeric filaments (Table 1). The gear combinations were chosen by taking into account the stability of the knitting and the quality of the knitted band. Other technological knitting conditions (tension of ground and weft threads, drawing-of force, etc.) were constant.



a) b)

Figure 2: Feeding of elastomeric thread on a crochet machine

Table 1: Production data

No.	Gearwheel		Pre-elongation of elastane (%)	Elastomer content in band with different weft yarn (%)		
	z_1	z_2		33.4 tex	66.8 tex	100.2 tex
1	27	21	280	51.4	41.5	35.1
2	27	23	300	49,0	39.8	34.8
3	27	25	330	47.4	37.6	32.8
4	29	23	330	47.7	38.2	32.2
5	29	25	365	45.4	35.8	32.1
6	31	23	360	45.3	36.5	30.5
7	31	25	395	44.7	36.5	28.7

2.2 Methodology

All knitted samples are conditioned by steaming and relaxing for 24 hours after knitting. Standard test methods were used to investigate the structural parameters of knitted materials [31–33]. Ten parallel measurements were done for each variant of elastic band.

The study of stretch properties of fabric was carried out on a relaxometer according to GOST 16218.9-89 [34] at a load of 25 N, which was selected by the number and diameter of elastomeric threads in the sample. Three parallel measurements were done for each variant of elastic band. The obtained results (Figure 3) showed a good convergence, which confirms their accuracy.

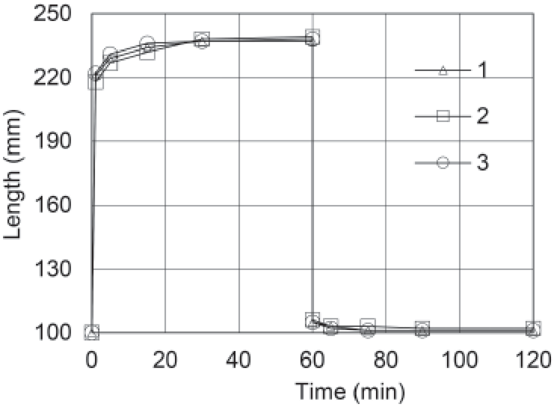


Figure 3: Dependence of a specimen's length on the cycling time for fabric #12

The studies of the coverage degree of the elastomeric threads by transverse weft threads were carried out by taking a photo of knitted samples at different elongation levels. A specimen was fixed in the clamps of a tensile testing machine; the camera was located to fix the middle part of the specimen. Stretching of the samples to a certain elongation (10%, 20%, 30% ... 100% was carried out at a constant speed (50 mm/min) of the lower clamp. The machine was stopped and a photo was taken.

3 Results and discussion

The structural parameters of elastic warp knitted bands are presented in Table 2 and in the graphs in Figures 4 and 5. It was observed that all studied knitted fabrics had two similar interdependent parameters: the number of wales per 100 mm, which was 74, and the length of the weft in-laying yarn per stitch of fabric, whose average value was 1.39 mm. For warp knitted fabric, these parameters mainly depend on the distance between needles, i.e. on the knitting machine gauge. Since all the samples were made on the same equipment, the values were unchanged.

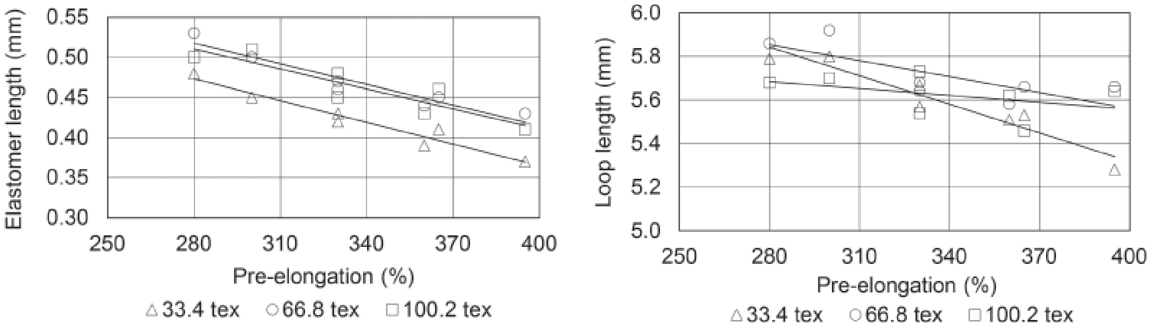
The thickness of the knitted fabric was a function of the interlooping, as well as the number and diameter of the threads that were used for its production. Thus, in this study, it only depended on the linear density (33.4 tex, 66.8 tex or 100.2 tex) of the weft inlay yarn. The band thickness yields a mean value of 1.35 mm, 1.40 mm and 1.43 mm respectively.

The results also showed that the preliminary elongation of the elastomeric filament (X2) significantly affected its length per stitch (Figure 4.a). When pre-elongation was increased from 280% to 395%, the length of the elastomer thread per stitch decreased by 10%, regardless of the linear density of the transverse weft yarn. It should be noted that the parameter's value for warp knitted bands with a 33.4 tex weft yarn was 10% less than for the corresponding fabrics with 66.8 tex and 100.2 tex weft yarns. The X2 increase also led to some reduction of the length of the ground pillar stitch (Figure 4.b). This can be explained by the change in the stresses in the draw-off zone because the pulling load is the determining parameter of the loop length on a warp knitting machine. In this case, the trend was more pronounced for knitted fabric with 33.4 tex weft yarn where the observed value decreased by 10%, while the value decreased by only 5% for warp knitted bands with 66.8 tex weft yarn and was practically constant for bands with 100.2 tex weft yarn. These observations were influenced by the increasing contact area between the weft and the elastomer yarns arising from the increase in the frictional forces, which affected the degree of elastomer relaxation in the knitted structure.

The number of courses per 100 mm is an indicator that determines the fabric density vertically and depends on the loop height inversely, and therefore on the elastomeric thread length per stitch. The effects of the structural parameters are shown in Figure 5a. The index increased by increasing elastomeric thread pre-elongation and was larger for bands with 33.4 tex polyester as weft inlay yarn. This means that reducing the linear density of the weft threads reduced the number and size of its contact zones with the elastomeric filaments, which contributed to the elastomer shrinkage in the knitted structure and the increase in the stitch density.

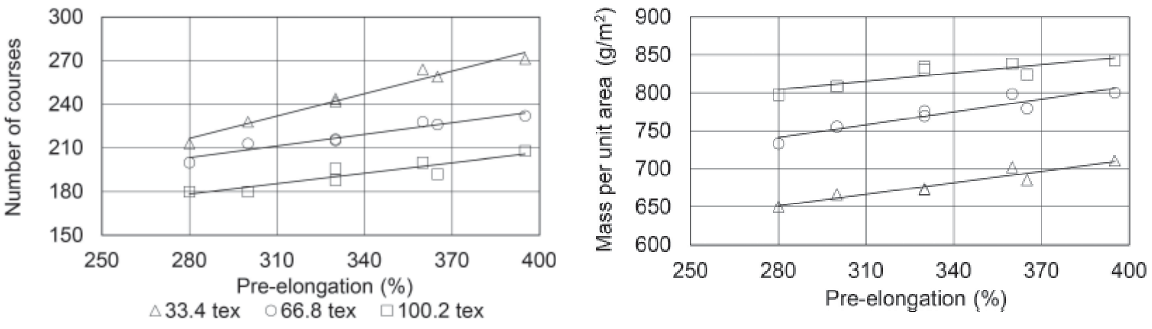
Table 2: Structural parameters of elastic warp knitted band

No.	Initial factors		Density (per 10 cm)		Loop length (mm)			Thick-ness (mm)	Mass per unit area (g/m²)
	Liner density of weft yarn (tex)	Pre-elon-gation of elastane (%)	Wales	Cours-es	Pillar stitch	Weft yarn	Elastomer		
1	33.4	280	74	213	5.69 ± 0.05	1.39	0.48 ± 0.02	1.34 ± 0.02	650.4 ± 1.3
2	33.4	300	74	228	5.80 ± 1.00	1.39	0.45 ± 0.01	1.34 ± 0.00	666.4 ± 1.6
3	33.4	330	74	242	5.77 ± 0.08	1.39	0.43 ± 0.01	1.37 ± 0.01	672.8 ± 1.5
4	33.4	330	74	244	5.57 ± 0.07	1.39	0.42 ± 0.01	1.34 ± 0.02	673.6 ± 1.4
5	33.4	365	74	259	5.73 ± 0.08	1.40	0.41 ± 0.00	1.35 ± 0.02	685.2 ± 1.8
6	33.4	360	74	264	5.51 ± 0.06	1.40	0.39 ± 0.00	1.37 ± 0.01	702.4 ± 1.5
7	33.4	395	74	271	5.28 ± 0.08	1.39	0.37 ± 0.00	1.35 ± 0.00	710.8 ± 1.7
8	66.8	280	74	200	5.86 ± 1.00	1.39	0.53 ± 0.02	1.40 ± 0.01	733.2 ± 2.0
9	66.8	300	74	213	5.92 ± 0.05	1.38	0.50 ± 0.02	1.40 ± 0.00	755.6 ± 2.0
10	66.8	330	74	215	5.64 ± 0.08	1.39	0.47 ± 0.01	1.40 ± 0.00	769.6 ± 1.8
11	66.8	330	74	216	5.68 ± 0.07	1.38	0.46 ± 0.01	1.41 ± 0.01	776.0 ± 2.1
12	66.8	365	74	226	5.66 ± 0.08	1.38	0.45 ± 0.01	1.41 ± 0.01	779.6 ± 1.9
13	66.8	360	74	228	5.58 ± 0.08	1.40	0.44 ± 0.01	1.41 ± 0.01	798.8 ± 2.0
14	66.8	395	74	232	5.66 ± 0.09	1.38	0.43 ± 0.00	1.40 ± 0.01	800.4 ± 1.8
15	100.2	280	74	180	5.68 ± 0.10	1.39	0.50 ± 0.01	1.43 ± 0.00	797.7 ± 2.0
16	100.2	300	74	180	5.70 ± 0.06	1.41	0.51 ± 0.02	1.43 ± 0.01	808.4 ± 2.1
17	100.2	330	74	188	5.54 ± 0.08	1.38	0.48 ± 0.02	1.43 ± 0.01	834.2 ± 1.9
18	100.2	330	74	196	5.73 ± 1.02	1.39	0.45 ± 0.01	1.42 ± 0.01	829.9 ± 2.0
19	100.2	365	74	192	5.46 ± 0.06	1.39	0.46 ± 0.01	1.42 ± 0.00	824.1 ± 2.1
20	100.2	360	74	200	5.62 ± 0.07	1.39	0.43 ± 0.00	1.43 ± 0.00	838.7 ± 1.9
21	100.2	395	74	208	5.64 ± 0.07	1.38	0.41 ± 0.00	1.42 ± 0.01	842.9 ± 2.2



a) *b)*

Figure 4: Effect of pre-elongation ε of elastomeric threads on thread length: a) elastomeric thread per loop and b) pillar stitch



a) b)

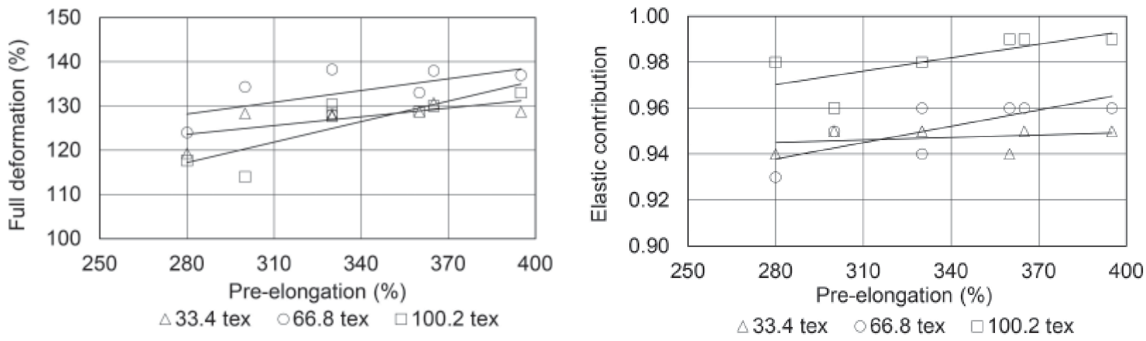
Figure 5: Effect of pre-elongation ε of elastomeric threads on structure parameters: a) number of courses per 100 mm and b) mass per unit area

Table 3: Stretch characteristics of elastic warp knitted band

No.	Initial factors		Full deformation (%)	Deformation components (%)			Contributions		
	Liner density of weft yarn (tex)	Pre-elongation of elastane (%)		elastic, ε_1	plastic, ε_2	rezidual, ε_3	Δ_1	Δ_2	Δ_3
1	33.4	280	119.3	112.0	6.3	1.0	0.94	0.05	0.01
2	33.4	300	128.3	121.7	5.3	1.3	0.95	0.04	0.01
3	33.4	330	127.7	121.0	5.7	1.0	0.95	0.04	0.01
4	33.4	330	128.0	121.3	5.3	1.3	0.95	0.04	0.01
5	33.4	365	130.7	124.3	4.7	1.7	0.95	0.04	0.01
6	33.4	360	128.7	121.3	5.7	1.7	0.94	0.05	0.01
7	33.4	395	128.7	121.3	5.7	1.7	0.95	0.04	0.01
8	66.8	280	124.0	115.7	6.7	1.7	0.94	0.05	0.01
9	66.8	300	134.3	127.7	5.7	1.0	0.95	0.04	0.01
10	66.8	330	138.3	130.7	6.3	1.3	0.94	0.05	0.01
11	66.8	330	128.0	122.7	4.0	1.3	0.96	0.03	0.01
12	66.8	365	138.0	132.7	4.0	1.3	0.96	0.03	0.01
13	66.8	360	133.0	128.0	4.0	1.0	0.96	0.03	0.01
14	66.8	395	137.0	132.0	4.3	0.7	0.96	0.03	0.01
15	100.2	280	117.7	115.0	2.7	0.0	0.98	0.02	0.00
16	100.2	300	114.0	109.7	4.0	0.3	0.96	0.04	0.00
17	100.2	330	128.3	126.3	2.0	0.0	0.98	0.02	0.00
18	100.2	330	130.3	128.3	2.0	0.0	0.98	0.02	0.00
19	100.2	365	130.0	129.0	1.0	0.0	0.99	0.01	0.00
20	100.2	360	128.7	127.7	1.0	0.0	0.99	0.01	0.00
21	100.2	395	133.0	132.0	1.0	0.0	0.99	0.01	0.00

The mass per unit area of the fabric determines material consumption and the weight of the finished product. The developed warp knitted bands contain elastomeric threads that were laid according to repeat, which facilitated a reduction in their basic weight by 20% compared to the fabric with a full set of elastomeric threads [35].

The results (Figure 5b) demonstrated that the mass per unit area of the warp knitted band increased by 10% with double density (66.8 tex) weft threads and



a) *b)*

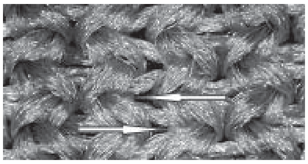
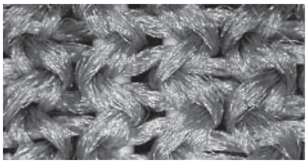
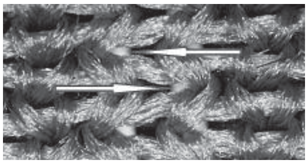
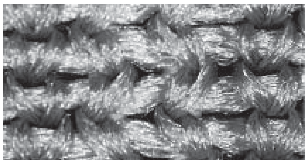
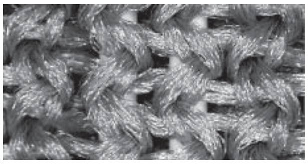
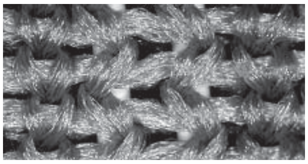
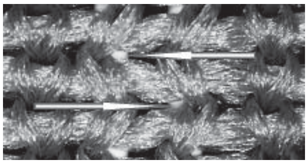
Figure 6: Effect of pre-elongation ε of elastomeric threads on stretch properties: a) full deformation and b) elastic deformation contribution

by 17% with triple density (100.2 tex) weft threads. The mass per unit area of the warp knitted band increased by 5–7% with an increase in of the pre-elongation of the elastomeric threads, which was mainly due to the vertical increase of the stitch density.

An investigation of the stretchability of elastic warp knitted fabrics was carried out by stretching the band walewise, i.e. in the direction of the inlaid elastomeric filament. Three parallel measurements were performed for each variant. The obtained results showed a good convergence, which confirms their accuracy. The results of full deformation and its components calculations are presented in Table 3.

As a result, it was established that the full deformation of the elastic warp knitted band (Figure 6a) was from 115% to 140%, which facilitates their use in medical binders and other support products. The full deformation of the investigated variants was directly proportional to the pre-elongation of the elastomeric filaments. Increasing the linear density of the weft

Table 4: Samples photos within stretching

Fabric elongation (%)	Liner density of weft yarn (tex)		
	33.4	66.8	100.2
0			
20			
40			
60			

inlay yarn resulted in a slight (within 10%) decrease of deformation. The dependence of the full deformation on the pre-elongation of the elastomer filament can be expressed as ($R^2 = 0.8$): $\varepsilon f = 94.1 + 0.1\ \varepsilon$.

The elastic component of the full deformation of warp knitted band had the highest content (≥ 0.93). Its value increased with the pre-elongation level of the elastomeric filament (Figure 6b), which confirmed the conclusions made by the authors in a previous study [22]: increasing the pre-elongation of elastomeric yarn leads to an increase in the yarn strain. As a result, the relaxation processes in the fabric structure are faster. The knitted band with 33,4 tex weft threads demonstrated the smallest level of elastic deformation.

It should be noted that the residual deformation of the elastic warp knitted bands was insignificant (did not exceed 1.7%) and therefore will not affect the quality of the medical and prophylactic products for which this elastic fabric is designed. It is obvious that the residual component of full deformation was near zero for the elastic band with 100.2 tex weft threads.

When using elastomeric yarn without any wrapping, the comfort of the fabric may be degraded. An elastomeric yarn should not be placed at the surface of the knitted structure as in the initial state as well as in a stretched state. Studies of the coverage degree of the elastomeric threads by transverse weft threads were carried out by taking a photo of knitted samples at different elongation levels (Table 4). A specimen was fixed in the clamps of the tensile testing machine; the camera was located to fix the middle part of the specimen. Samples were stretched to a certain elongation (10%, 20%, 30% ... 100%) at a constant speed (50 mm/minute) of the lower clamp. The machine was stopped and a photo was taken. Obviously, at the initial state (elongation 0%), the transverse weft threads completely covered the elastomer, preventing it from reaching the surface in all samples. For samples with a 33.4 tex transverse weft thread, the elastomer was visible even at 20% elongation. For samples with a 100.2 tex, the transverse weft thread visibility of the elastomer was observed at 60% or higher elongation.

4 Conclusion

An elastic warp knitted band for use as a fixing element in rehabilitation and prophylactic products has been developed. It is proposed that the elastic thread should not be inlaid in every wale and the guide bar threaded according to repeat 2: 1 in order to reduce the material consumption and product's weight. This results in a 20% reduction in the mass per unit area of the warp knitted band, while maintaining relaxation characteristics within the relevant requirements for rehabilitation and prophylactic products. Based on the two-factor experiment planned and conducted in the work, the following was concluded:

- the linear density of the weft yarn (X1) affected the thickness, vertical density and surface density of the knitted material, and, to a lesser extent, the content of the elastic component in full deformation; and
- the pre-elongation of the elastomeric threads before the knitting zone had a significant effect on the vast majority of the investigated properties: an increase in pre-elongation from 280% to 395% which led to
- an increase in the number of courses per 100 mm by 15–27%, mass per unit area by 7–10% and full deformation and its elastic component by 15%, and
- a decrease in the length of the elastomer filament per stitch by 10%, as well as the residual component of the full deformation**.**

From the result of our studies, it was found that the use of 100.2 tex transverse weft threads guarantees full coverage of the elastomer within the elastic band's elongation of up to 60%. Despite the fact that there is 15–20% saving in material consumption and that fabrics satisfy the elasticity indices when using 33.4 tex transverse weft thread, their use is not recommended since even with an elongation of 20% there is the possibility of elastomeric threads making contact with the human body.

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