STUDY CONCERNING THE STRUCTURE-PROPERTIES CORRELATION FOR ELASTIC NARROW FABRICS

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REZUMAT: In lucrare s-a urmarit evidentierea corelatiilor dintre structura, proprietati si tehnologia de realizare a benzilor elastice tesute. Benzile elastice sunt articole de pasmanterie realizate prin folosirea firelor de cauciuc sau a altor fire elastice de tipul elastomerilor. Articolele de pasmanterie elastice se produc atât țesute, cât și împletite, croșetate sau tricotate. Am abordat acest studiu deoarece ponderea cea mai mare o au însă benzile țesute, mai ales datorită stabilității lor în timpul utilizării cât și datorită faptului că prin țesere se obține o omogenizare mai bună a firelor elastice și neelastice care concură la formarea produsului. Datorită faptului că domeniile de aplicare sunt multe și diversificate o direcție prioritară la proiectarea produselor elastice va fi aceea de luare în considerare a condițiilor de exploatare. Este important ca firele de cauciuc sau elastomer să nu-și piardă gradul de elasticitate. Deformarea în lungime după țesere este un aspect specific articolelor elastice și influențează puternic structura benzilor, constituind unul din factorii de bază care trebuie avut în vedere la proiectarea lor.

Cuvinte cheie: benzi elastice țesute, diagrama efort-alungire, articole de îmbrăcăminte, legatura panză

ABSTRACT: The work is meant to render evident the correlation between structure, properties and manufacturing technology of the elastic narrow fabrics. The elastic narrow fabrics are lace-working articles produced by using rubber yarns or other types of elastic elastomer-type yarns. Elastic lacing articles are produced woven, braided, crocheted or knitted. We have approached this study because the highest weight belongs to narrow fabrics, especially due to their stability during utilization and to the fact that by weaving one obtains a better homogenization of the elastic and inelastic yarns that concur in product realization. Given the fact that there are many and diversified fields of application, a prevailing direction in designing elastic product will be to take into account the exploitation conditions. It is important that rubber or elastomer yarns do not loose their elastic ratio. The longitudinal deformation after weaving is an aspect specific to elastic articles and it strongly influences the narrow fabrics structure, representing one of the basic factors to be considered when designing them.

Keywords: elastic narrow fabrics/bands, stress/strain diagrams, articles of clothing, plain weave

1.INTRODUCTION

Woven elastic band is so strong that it can be used for "heavy duty" applications like car covers, home decorating, and strapping [1,2]. A variety of elastic fabrics is used for making. Such fabrics generally contain elastane, which has the disadvantage of exerting a visco-elastic response to an applied load [3,4]. Narrow fabric elastic tapes are essential components in intimate apparel to provide support, hold the garment in the right position, create a finished edge, and give aesthetic effects [5]. Woven elastic tapes are usually smoother, finer, and flatter than crochet elastic tapes. Elongation, modulus, durability and aesthetics are the key criteria in the selection of narrow fabric elastic tapes for apparel [6]. By the very nature of its construction, woven elastic is a high-strength material that bends and moves with everyday use, but will not narrow when stretched. With double the amount of elastic material, woven elastic is by far the best option when stretch is important.

That extra material either polyester or cotton woven elastic also translates to greater strength and durability [7]. The type of elastic band is categorized by how it is constructed and its fiber content as: braided elastic, knitted elastic and woven elastic. Elastic band is made from a series of rubber either natural or synthetic. It has significant value for use in textile industry because of its excellent elongation and recovery properties [8,9]. The word "Spandex" is a general term used to define elastic material. The use of elastic yarn in fabric manufacturing gave new life to the use of elastic fabric in fashionable garment [10].

2. EXPERIMENTAL PART

2.1. Materials and methods

The study has been carried out on three samples of elastic narrow fabrics/bands produced on Jacob Muller weaving machine, encoded as B1, B2 and B3. The structural characteristics and the properties of the analyzed elastic narrow fabrics have been determined by standardized methods.

The basic materials used in the realization of elastic narrow fabrics/bands are: yarns of lycra or other elastomers, polyamide, polyester, cotton or blended yarns. Elastic narrow fabrics/bands can be weaved with widths ranging between 3 and 235 mm, the knitting - up to 50 mm width and those inscribed with widths up to 60 mm. As a main, the woven elastic narrow fabrics/bands consist of at least two warps (elastic and inelastic warp) and a weft.

There is a wide diversity of the utilization fields that use elastic products, such as: garment, knitting, furnishings, medical articles, etc. For each field of application, the products have specific properties, obtained by an adequate designing process.

Given the fact that the application fields are numerous and diversified, a priority direction in designing the elastic products will be to take into account the exploitation conditions. We refer to microclimate conditions, aggressive chemical agents, mechanical stress conditions (more or less elongated), utilization duration, etc.

The main exploitation property of the elastic narrow fabrics is elasticity. Rubber yarns resist to an elongation ranging between 400% and 700%; when exceeding this elongation, the rubber yarns no longer resist and they break. Rubber yarns are processed under optimum conditions at an elongation of 400 ÷ 500%. Still another exploitation property consists in thermal behavior of rubber yarns. They do not resist at very high temperatures, their breaking down temperature ranging between 150^{o}C and 175^{o}C; the carbonization temperature ranges between 230^{o}C and 290^{o}C. They neither resist at very low temperatures, these making the rubber yarns to freeze and burst.

Utilized basic material and designed structure must respond to these demands. For the basic warp yarns, it is considered that basic materials such as cotton, polyester and polyamide have the widest coverage area and respond the best to the above-mentioned conditions.

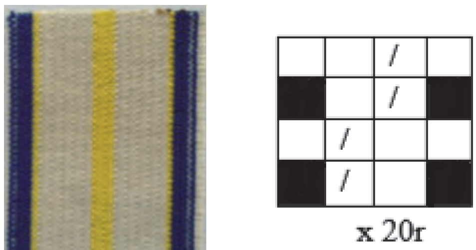
What concerns rubber or elastomer yarns, it is important for them not to lose their elastic ratio. The adequate basic material and structure for these products are adopted punctually and correspond to each category of products apart.

The physical- mechanical properties of the studied narrow fabrics have been determined on TINUS OLSEN H5KT dynamometer.

2.2. Results and discussions

For each analysed narrow fabric we have determined the structural characteristics: weaving type, technological yarn setting, mass, thickness, elastic ratio and yarn number of the narrow fabric. For the representation of the weaving patterns, one has used the following graphic signs corresponding to warp effects: ”/” binding warp yarns; ”■” rubber warp yarn; “O” filling yarns; “X” limiting yarns.

Narrow fabric B1 has inelastic warp repp weave $R\frac{2}{2}u$, and warp rubber yarns plain weave. Weave aspect and type for narrow fabric 1 are presented in Fig. 2.1, where one can see the different aspect of the two sides; on the face - a repp aspect with warp effect, and on reverse - a repp aspect with weft effect. The rubber yarns from narrow fabric composition have round section and are not wound with inelastic yarn, which confers the narrow fabric a higher elastic ratio. The rubber yarn diameter dc = 0.64 mm.



Narrow fabric 1 — Weave $R\frac{2}{2}u$

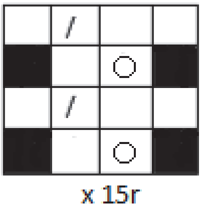
Fig.2.1 Weave aspect and type

These narrow fabrics have the width of 3.4 cm; they do not contain filling yarns and are used to realize haberdashery articles, namely elastic braces (Fig.2.2).

Fig.2.2. Field of utilization - 1

Narrow fabric B1 is a simple plain weave narrow fabric with the width of 2.3.cm. Its composition includes filling yarns placed near rubber yarns and they are meant to fill up the channels around them. Both the warp filling yarns and tie-up and rubber yarns follow the evolution of the plain weave. The aspect of this narrow fabric is identical on the face and on reverse (Fig.2.3).

Farrow fabric/ band 2



Plain weave

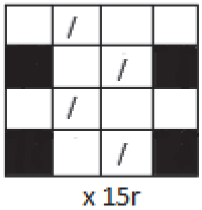
Fig.2.3 Weave aspect and type

Rubber yarns from the composition of this narrow fabric/band have round section and are not wound with other inelastic yarns, and the rubber yarn diameter in this case is dc= 0.6 mm. This elastic narrow fabric/band is used in garment industry (Fig. 2.4) to manufacture articles of clothing (trousers, skirts with waistband / waist belt, etc).

Fig.2.4. Field of utilization- Narrow fabric 2

Fig.2.5 presents the weave aspect and pattern for narrow fabric/band B3, with the width of 1.9cm, at which both the warp inelastic yarns and the warp rubber yarns weave the fabric. The aspect of this narrow fabric/band is identical on the face and on reverse. Rubber yarns have round section, their diameter dc being equal to 0.5 mm and they are not wound with inelastic yarns.

Narrow fabric 3



Plain weave

Fig.2.5 Weave aspect and type

This narrow fabric/band is used in garment industry to realize various articles of clothing (Fig.2.6)

Fig.2.6 Fields of utilization -B3

Table1 **Structural characteristics of th elastic narrow fabrics**

Cod	Yarn count (yarns/cm)		Band width (cm)	Number of yarns from narrow fabric	Narrow fabric mass (g/m)	Thickness (mm)
	Warp	Waeft				
B1	19	25	3.4	85	34.47	1.88
B2	28	38	2.3	88	18.53	1
B3	25	31	1.9	59	11.9	0.87

Making a comparative analysis of the three narrow fabrics/bands, based on experimental data from Table 1, one can notice that there is clear difference between them from the standpoint of both narrow fabric/band widths and their thickness and elasticity.

As one can see from Fig.2.7, the narrow fabric/band B1has the highest elastic ratio with an average thickness, being followed by narrow fabric/band B3, narrow fabric/band B1 having smallest elastic ratio.

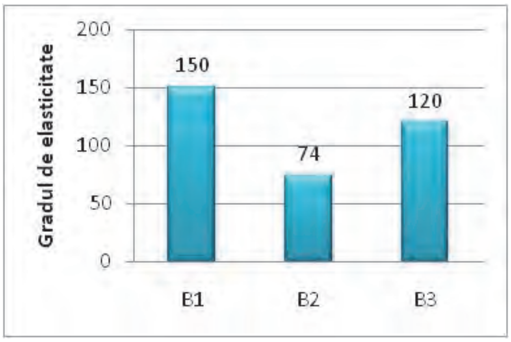


Fig. 2.7. Evolution of elastic ratio for the three narrow fabrics/bands

For the analyzed narrow fabrics/bands we have determined the breaking force and breaking elongation on TINUS OLSEN H5KT dynamometer, and have recorded the stress- strain ratios in the longitudinal direction. The indices of stress properties assessment have been also calculated from the stress/strain diagrams (Fig.2.8; 2.9; 2.10).

From the analysis of the values of indices of tensile properties appraisal inferred from the stress - strain diagrams (Table 2), one can notice that the narrow fabric/bandB1 has the biggest elasticity, but not the best. Narrow fabric B3 is characterized by a good elasticity, having the smallest slope at the proportional limit, being followed by B1 and finally by B2. The product with the best elasticity is the one with the smallest slope, because the elongation is made without loading, namely narrow fabric/band B3.

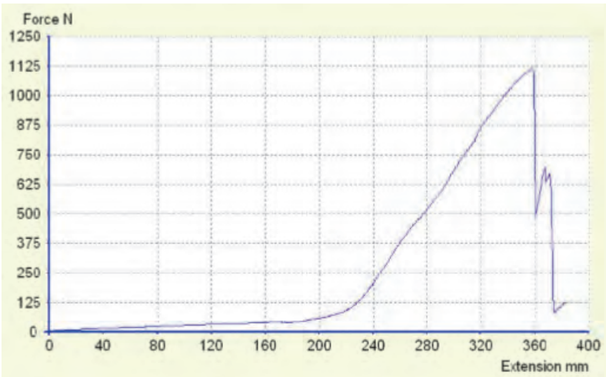


Fig.2.8. Stress - strain diagrams -B1

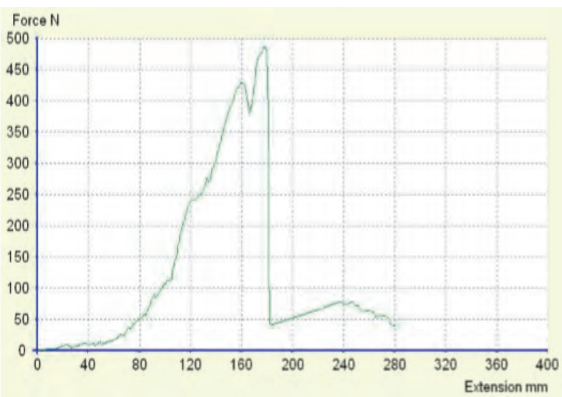


Fig.2.9. Stress - strain diagrams -B2

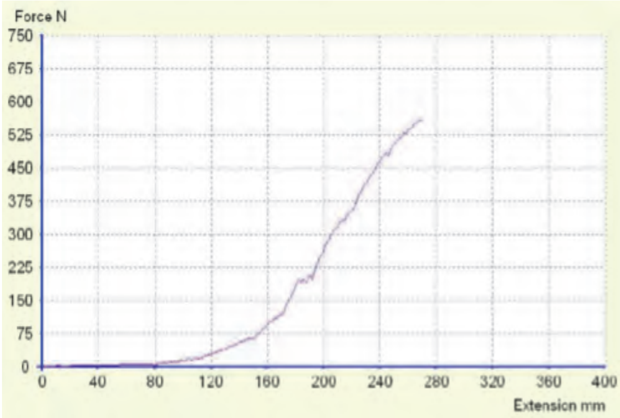


Fig.2.10. Stress/strain diagrams-B3

Table 2 **Indices deduced from stress - strain diagram**

Indices deduced from stress/strain diagram	**B1**	**B2**	**B3**
Breaking force (N)	1114	486	559
Relative elongation (%)	766.4	561.6	540
Proportional limit (mm)	219.2	80	145.6
Absolute elongation (mm)	383.2	280.2	270
Breaking energy (J)	101.1	34.16	40.21
Slope at proportional limit (N/mm)	0.281	0.2917	0.1636

Elastic narrow fabrics/bands are obtained by including in the fabric, elastic warp yarns, which, on the weaving machine are processed in tensile condition, the extension being obtained through a very strong braking of the elastic warp.

The analysis of the elastic ratio is performed by means of subjective extension and of the indices deduced from stress - strain diagram of the analyzed narrow fabric/band: proportional limit, proportional limit slope and breaking energy. The stress - strain diagram renders evident the fact that samples braking does not occur suddenly, but gradually, the rubber yarns being the last to break, one by one. The number of yarns from the narrow fabric/band gives the resilience of the narrow fabric/band.

3. CONCLUSIONS

Woven elastic narrow fabrics/bands have the highest preponderance due to both their stability during utilization and to the fact that by weaving one obtains a better homogeneity of the elastic and inelastic yarns that compete in product realization.

From the exhibition of the presented applications, one can notice that there is a wide diversity of the utilization fields where the elastic products are used. For each application field, the products have specific properties which are obtained through an adequate designing process.

Elastic narrow fabrics/bands can be realized as simple or composite structures, with or without filling yarns, with or without special ornamentation effects of the surface or selvages. Simple structure narrow fabrics/bands have the same aspects on both the face and the reverse, while narrow fabrics/bands with composite structure have different aspects on the two sides.

Warp setting of weave/tie-up and filling yarns has a great influence on product elastic ratio. Weft setting can influence the contraction in a very large extent. The elasticity of an elastic narrow fabric/band is determined by the influence of the initial extension of the elastic yarns and the weft setting, by weft yarns thickness, weave segment, inelastic warp thickness and density, as well as on tensile degree of inelastic weft yarns. The differences of stress between rubber yarns that enter the narrow fabric/bandcomposition result in a tendency of narrow fabric/band bending. The narrow fabric/band bending tendency that cannot be eliminated result from the difference of stress between the rubber yarns from the narrow fabric/bandcomposition, which cannot be eliminated by changing the margin wire, is due to the difference of stress between the rubber yarns, which are a component of narrow fabric/band.

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