THE EVALUATION OF DURABILITY CHARACTERISTICS FOR KNITTED USED IN HOMETECH TYPE ARTICLES

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REZUMAT. Pentru tricoturile destinate articolelor de tip Hometech, evaluarea calităţii presupune analiza corespondenţei dintre cerinţele beneficiarilor, funcţiile şi caracteristicile de calitate reprezentative şi aplicarea metodelor standardizate, în vederea alegerii variantelor de tricot optime pentru destinaţia impusă. Lucrarea are ca obiectiv evaluarea comparativă a caracteristicilor de durabilitate pentru un sortiment de tricoturi integrate (măsurarea rezistenţei la întindere până la rupere şi testarea aderenţei).

Cuvinte cheie: calitate, evaluare, caracteristici, tricoturi, saltele, tapiţerie, decoraţiuni interioare

ABSTRACT. For Hometech used knitted, quality assessment involves analyzing the correspondence between the requirements of the beneficiaries, the functions and the representative quality characteristics and the application of standardized methods in order to choose optimal knitted variants for the required destination. This paper aims to evaluate comparatively the durability characteristics of an assortment of integrated knitwear (measuring stretch-to tear resistance and adherence testing).

Keywords: quality, evaluation, characteristics, knitted, mattresses, upholstery, interior decoration.

1. GENERAL CONSIDERATIONS

Innovation in textile products has reached unpredictable rates in recent years. In a relatively short period (the last 50 years), the textile industry has undergone revolutionary changes with most remarkable innovations. These have led to the expansion of high-tech technical textiles with multifunctional uses (garments, environmental protection, geo-textiles etc.), of those with special properties (anti-ballistic, chemical, biological protection etc.), considered passive systems, and of product that "sense" and react to external stimuli of mechanical, thermal, chemical, magnetic nature and so on.

In this respect, knitted are successfully used in almost all human activities: industry, agriculture, army, medicine, sports, leisure etc. (Agrotech, Buildtech, Clothtech, Hometech, Geotech, Medtech, Protech, Sporttech, Mobiltech, Indutech, Packtech, Oekotech – figure 1). This is due to the many advantages offered:

- diversity of presentation forms;
- reduced specific mass compared to other textile materials;
- creation of knitted structures combining the characteristics of woven fabrics (resistance to mechanical stress, reduced extensibility), with those knitted specific (spatial modelling capacity, voluminousness, possibilities for extended diversification, pleasant touch, high economic efficiency);

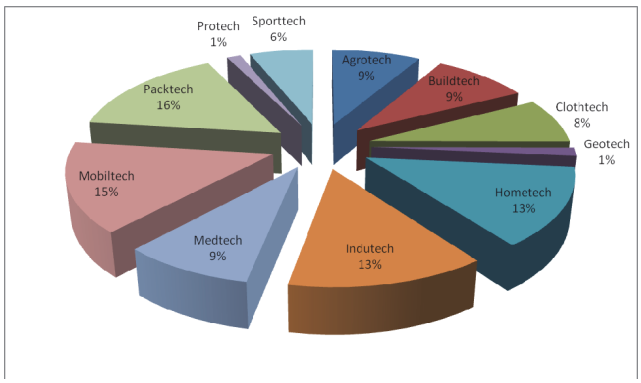

Fig. 1. Textile products distribution in main activity domains.

- development of new knitting technologies;
- possibility of directing specific characteristics;
- use of an extended range of yarns with superior features.

2. TECHNICAL TEXTILES USED IN HOMETECH ARTICLES MANUFACTURING

The technical knitted used in mattress manufacturing, upholstery articles and interior decorations (Hometech branch) comprise a wide range of products of different structures and raw materials, which must meet the specific requirements requested by the beneficiaries:

- constructive requirements: dimensional correspondence, composition, structure, mass;
- aesthetic requirements: mattress appearance, material used for upholstery, the color or the chromatic combination, seams appearance, etc.;
- thermal and sensorial comfort requirements, flexibility, extensibility, elasticity;
- health protection requirements, harmful substances content, flammability, degradation capacity in a biological environment;
- availability requirements: durability, preservation of shape, appearance, colors and dimensions;
- requirements for cleaning, remedy and reconditioning, decontamination capacity etc..

These requirements are crucial in the creative process and design, completed by product and process documentation.

Evaluating product quality involves establishing representative features in relation to their intended use and applying standardized testing methods to select optimal variants. Testing is an essential part of the engineering activity, found in production processes to ensure that technological parameters are kept under control and product quality is properly achieved. By testing, the industrial activity pursues two objectives: to determine certain quality characteristics of textile products; to determine the influence degree of some features or parameters, on the behavior of a product during use.

2.1 Presentation of integrated knitted used in Hometech articles

Products meant for mattresses, upholstery, or interior design, made of knitted, are characterized by an extremely varied design, structural diversity, raw materials of remarkable variety, including ecological and biodegradable ones, durability and versatility.

These aspects result in customer satisfaction during visual and tactile analysis of the product (its appearance, knitted used, chromatic combination, handling, etc.) as well as improved performance during use.

Integrated knitted are highly complex structures, multilayer type, made of yarns chosen specifically as to produce special characteristics in close connection with the destination. As such, the yarns used in the two faces of the knitted must have aesthetic, comfort, protection and durability characteristics, while filling yarns are designed to provide thermal insulation and elastic recovery capacity. In this paper we studied six variants of integrated knitted presented in Table 1.

Table 1. **Characteristics of integrated knitted variants**

Knitted variants	Structure	Prime matter			Filling yarns sequence	Thickness [mm]	Weight [g/m^2]	Special characteristics
		Front yarns	Back yarns	Filling yarns (weft yarns)				
V 1	**Double relief rib jacquard**	Bamboo viscose Nm 20/1	PES 150 den	PES 1200 den	1/4	2,49	250	Use of ecological yarns (bamboo) High thermic comfort
V 2	**Double relief rib jacquard**	Bamboo viscose Nm 20/1	PES 150 den	PA 1250 dtex	1/2	3,21	320	
V 3	**Double relief rib jacquard**	Bamboo viscose Nm 20/1	PES 150 den	PES 600 den	1/4	3,15	264	
V 4	**Irregular Jacquard**	PES Nm 18/1	PES 150 den	PES 600 den	1/4	1,59	245	Using yarns of different matte grade High thermic comfort
V 5	**Double relief rib jacquard**	PES Nm 18/1	PES 150 den	PA 1250 dtex	1/3	2,48	350	Using yarns of different shine grade
V 6	**Irregular Jacquard**	52% PES+48% viscose Nm 20/1	PES 150 den	PES 1200 den	1/2	2,68	342	Using mixed yarns (PES and viscose) leads to improved comfort and ecological characteristics

3. EVALUATION OF INTEGRATED KNITTED

Mechanical stress of static nature (extensibility / elasticity, tear strength and elongation, piercing resistance, tearing, etc.) and non-destructive or destructive dynamic ones (shock resistance) are often encountered during product use. They can be performed in a cycle (tear resistance, piercing, tearing), or in several cycles (elasticity, fatigue resistance, friction, pilling). These types of stresses provide valuable insight into a number of product quality features (extensibility, elasticity, rheological characteristics).

The assessment of textile surfaces behavior at these types of stresses is achieved through indicators, which are product quality characteristics, generally standardized.

In order to evaluate the durability of integrated knitted fabrics for mattresses, upholstery and interior decorations (slipcovers, bed spreads, etc.) were considered as representative, stretch-to-tear stresses (using the textile dynamometer) and adhesion testing (using the Shirley apparatus).

3.1. Evaluating integrated knitted to stretch-to tear stress

Testing the behavior of the integrated knitted fabrics during stretch-to-tear stresses was performed on the six knitted variants presented above on three stress directions: longitudinal (stitch columns), transverse (stitch rows) and diagonal, which forms an angle of 45° with the vertical.

The average values obtained are centralized in Table 2.

The comparative analysis of the tear strengths, for the six knitted variants is suggestively illustrated in Figures 2, 3, 4, 5.

Table 2. **Values of tear resistance and elongation**

Knitted vari-ants	Tearing resistance R_T [daN]			Tearing elongation ε [%]		
	Col	Row	Dia-gonal	Col	Row	Dia-gonal
V 1	54,6	67,0	54,0	105	55,0	70,0
V 2	55,1	68,4	54,8	105	54,0	72,0
V 3	41,2	46,4	34,8	92	55,0	95,0
V 4	57,8	60,0	57,0	84	40,0	41,0
V 5	59,4	61,9	58,1	82	42,0	43,0
V 6	56,7	68,0	56,4	79,0	39,0	42,0

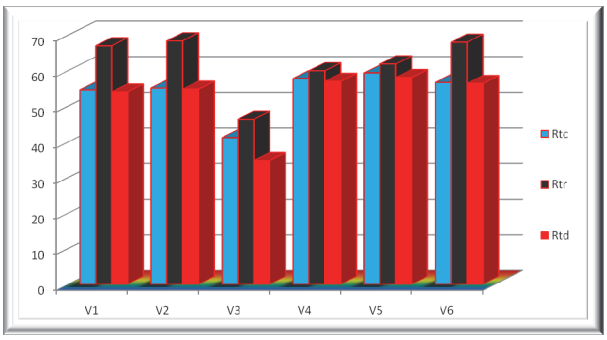

Fig. 2 Comparative analysis of tearing resistance variation on the three stress directions for the knitted variants tested

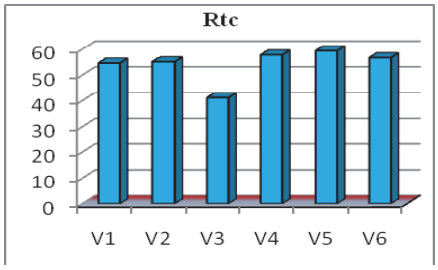

Fig. 3 Comparative variation of tearing resistance on the stitch columns for the knitted variants tested

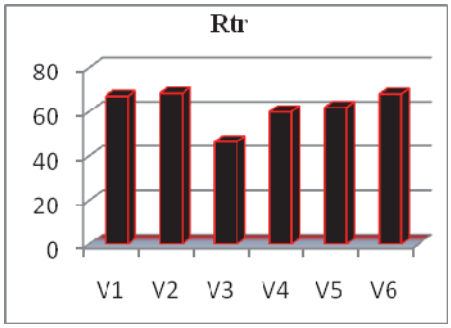

Fig. 4 Comparative variation of tearing resistance on the stitch rows for the knitted variants tested

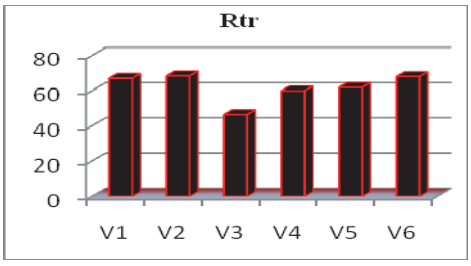

Fig. 5 Comparative variation of tearing resistance on the diagonal direction for the knitted variants tested

Conclusions regarding knitted behavior to uniaxial stretch to tear stress:

- Tearing resistance values, on the three stress directions, are not significantly influenced by the thickness, or the mass of the knitted, but only by the raw material processed, the linear density of the filling yarns processed, and the number of binding points between the two layers of integrated knitted;

- In this respect, the knitted variants made of PES yarns, on both front and back (V4, V5, V6), show the highest values of tear resistance on the longitudinal and diagonal stress directions compared to the other knitted variants analyzed;
- The highest resistance values (over 65 daN) were recorded on the transverse direction (of stitch rows) in all six analyzed knitted variants. This is explained by the distribution of forces both on the stitch elements (needle loops and jack loops) and on the filling yarns, inserted between the two layers of the knitted;
- Of the six knitted variants analyzed, the highest transverse resistance values are for the knitted V2, V6 (over 68 daN) and V1 (over 67 daN);
- The lowest resistance values, on the three stress directions, were recorded in the V3 variant that contains bamboo viscose yarns on the front, but also the lowest filling yarns count. Even if the V4 variant has the same filling yarns count, the fact that it is made on the front with PES yarns compensates for this;
- Comparing the variants V1, V2, V3 (made from the same types of yarns) it is observed that the lowest resistance on the transverse direction is for the variant V3, although the filling yarn ratio (B) is higher (1/2 compared to 1/4); This is explained by the fact that the filling threads on V3 have a much lower count (600 den), compared to 1200 den, on V1 and 1250 dtex on V2.

The comparative analysis of the variation of tearing elongations, for the six knitted variants is precisely illustrated in figures 6, 7, 8, 9.

Conclusions regarding the behavior of knitted on uniaxial stretch to tear stresses:

- From the graphs presented, it is observed that the elongations are lower on transverse direction (of stitch rows), compared to the other directions of stress;
- The highest values of the elongation were recorded on the longitudinal direction (of stitch columns); Of these variants, V1 and V2 have elongation values of over 100%;
- The lowest elongation values are for the knitted variants V4, V5, V6.

Due to the fact that tearing resistance can be associated with the product's ability to maintain its integrity at destructive stresses that may occur during use, and the elongations can be associated with shape stability, it can be considered that:

- The best variants, with superior behaviors during use (minimal risks of losing their initial characteristics) are V4, V5, V6 variants;
- The worst variant of the six analyzed (with the highest risk of deformation) is variant V3.

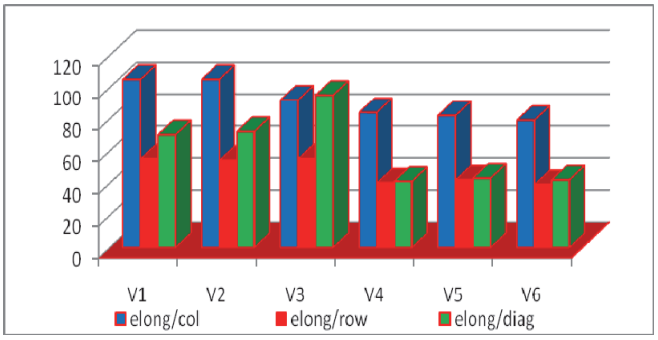

Fig. 6 Comparative analysis of tearing elongation variation on the three stress directions, for the knitted variants tested

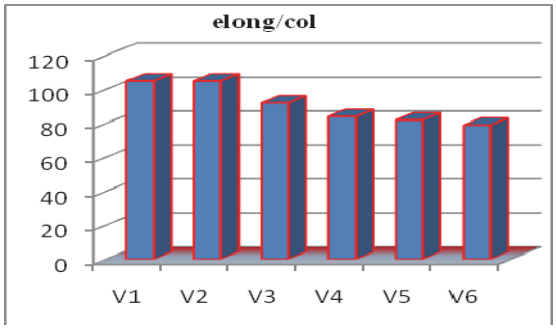

Fig. 7 Comparative analysis of tearing elongation variation on stitch columns direction for the knitted variants tested

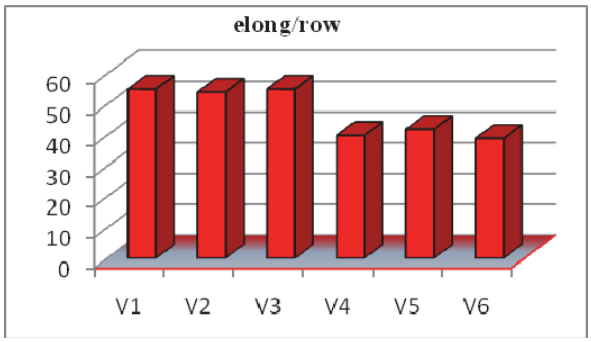

Fig. 8 Comparative analysis of tearing elongation variation on stitch rows direction for the knitted variants tested

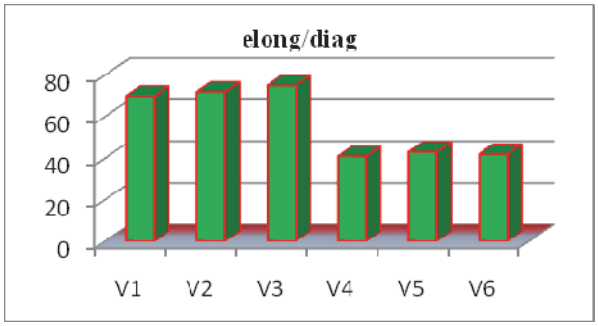

Fig. 9 Comparative analysis of tearing elongation variation on the diagonal direction for the knitted variants tested

3.2. Testing the adherence of integrated knitted

The adherence capacity of the knitted (resistance to friction by sliding) with the help of the Shirley apparatus, must be measured on both sides of the fabric: on the front (which the user comes in contact with) and on the back (which comes into contact with the covered surface). Due to the different unevenness of the knitted, the testing was carried out on two stress directions: the longitudinal direction (of the stitch columns) and the horizontal direction (of the stitch rows).

The centralization of the average values obtained for the friction coefficient is shown in Table 3.

Table 2. **Median friction coefficient values for integrated knitted fabrics**

Variantă tricot	Median friction coefficient values μ			
	Fabric's front		Fabric's backs	
	Col	Row	Col	Row
V 1	0,64	0,71	0,58	0,78
V 2	0,59	0,78	0,60	0,77
V 3	0,56	0,69	0,53	0,71
V 4	0,84	0,82	0,60	0,78
V 5	0,75	0,78	0,59	0,82
V 6	0,81	0,88	0,61	0,81

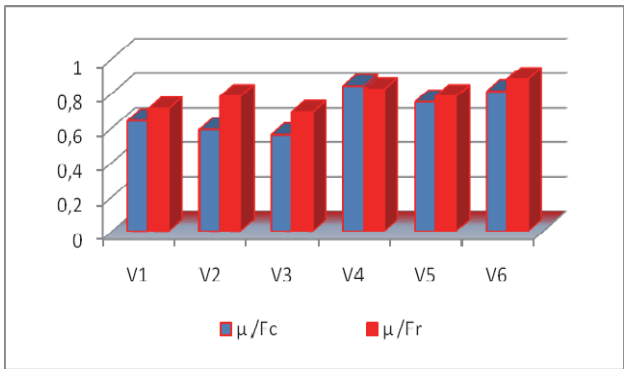

Fig. 10 Comparative analysis of the variation of friction coefficient values in knitted fronts, on the column direction, respectively stitch rows direction.

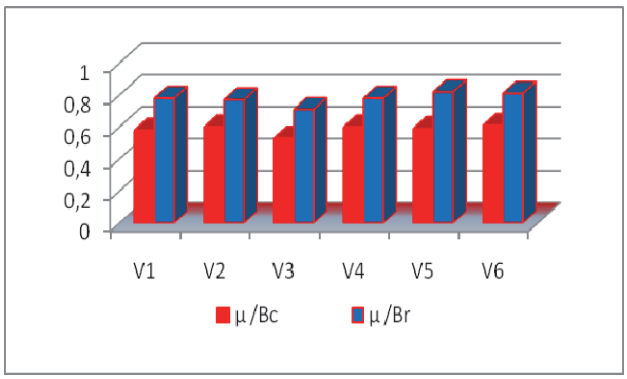

Fig. 11 Comparative analysis of the variation of friction coefficient values in knitted backs, on the column direction, respectively stitch rows direction.

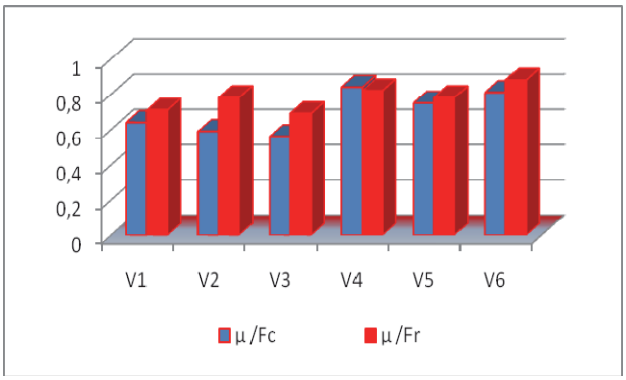

Fig. 12 Comparative analysis of the variation of friction coefficient values in knitted fronts, respectively backs, on stitch column direction

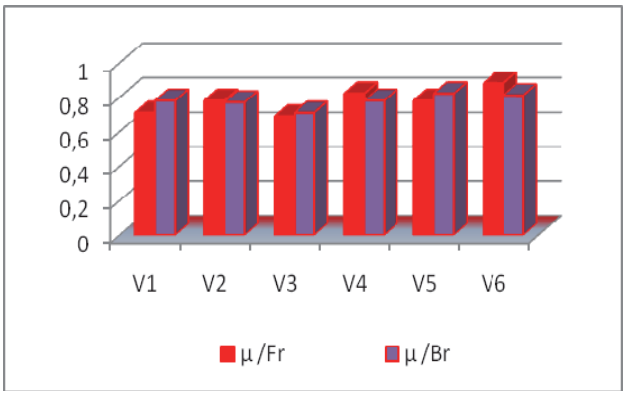

Fig. 13 Comparative analysis of the variation of friction coefficient values in knitted fronts, respectively knitted backs, on stitch rows direction

The comparative analysis of the friction coefficient values, for the six knitted variants tested, is precisely illustrated in figures 10, 11, 12, 13.

Conclusions regarding knitted adherence:

A comparative analysis of the friction coefficient variation for the six knitted variants, analyzed both on the direction of stitch row and stitch column, revealed the following conclusions:

- The value of the friction coefficient on the two sides of the knitted is determined on one hand by their structure and on the other by the fibrous composition of the processed yarns;
- Thus, the fibrous compositions of the variants V6 (PES yarns mixed with viscose), V4, V5 (PES yarns) have a significant influence on the value of the friction coefficient, corresponding to its increase, compared to the variants V1, V2, V3, in which the fibrous composition (bamboo with viscose) causes it to decrease;
- It is considered to be more advantageous in terms of destination, knitted variants with a higher friction coefficient, both on the front (which the user comes in contact with) and on the back (which comes into contact with the covered surface);

- In this respect V6, V4, V5 have the highest friction coefficient values on the knitted front;
- The fibrous composition of the V6 variant (mixed PES yarns with viscose), but also those of to V4, V5 variants (PES yarns) have a significant influence on the value of the friction coefficient, corresponding to its increase, compared to variants V1, V2, V3, in which the fibrous composition (bamboo with viscose) causes it to decrease;
- The value of the friction coefficient is influenced by the degree of surface irregularity. From this point of view, the highest values of the friction coefficient were recorded in the variants V6, V4, V5, which have a raised appearance;
- On both the front and the back of the knitted, the value of the friction coefficient recorded on the direction of the stitch row is greater than that measured on the direction of the stitch column.

4. CONCLUSIONS

Based on the analysis of the correspondence between the specific requirements of the beneficiaries, the functions and quality characteristics of the integrated technical knitted, for the assessment of their durability, it has been established as a priority measuring the stretch-to tear resistance (using the textile dynamometer) and testing the adherence (using a Shirley apparatus).

Due to the fact that **tearing strength can be associated with the product's ability to maintain its integrity at destructive stresses,** that may occur during use, and **elongation may be associated with shape stability**, it has been determined that:

- the best variants, with superior behaviors during use (minimal risks of losing their initial characteristics) are the variants of integrated knitted V4, V5, V6;
- the worst variant of the six analyzed (with the highest risk of deformation) is variant V3.

Testing the adherence of knitted during use, is particularly important and is **significantly influenced by their structure, fibrous composition of the yarns and degree of irregularity of the surface**.

In this respect, the best tested variants, with superior behavior during use are the V4, V5, V6 integrated knitted variants.

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