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CREASING BEHAVIOR OF SOME WOVEN MATERIALS MADE FROM COMBED YARNS TYPE

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Abstract: *The paper analyses the behavior to creasing of some woven materials made from yarns type wool used for ready-made clothes. Factors like fibrous composition, properties of constituent fibers, wovens structure parameters, mechanical properties of warp and weft yarns and finishing treatments that influenced the recovery capacity from crease/folding were investigated experimentally through several tests which revealed their importance in the process.*
The creasing of woven materials made from combed yarns type wool used for ready-clothes is an undesired deformation effect with temporary or permanent character, which is caused by a composed strain of bending and compression during utilization, processing or maintenance. It is manifested by the appearance of wrinkles, folds or stripes on the surface of wovens materials, thus diminishing their qualitative appearance and also their practical value.
Creasing is the result of irreversible changes created through the reciprocal sliding of structural fiber components when exposed to a bending strain. Creasing is specific to oriented structures with high crystallinity (cellulosic fibers). The sliding appears because of hydrogen bond breaking which can, however, reform easy in other positions conferring a permanent character to creasing.Functional apparel will be subjected to a wide range of end uses such that a garment will be affected by intern (fibres, yarn fineness warp/weft, fabric density, thickness, fabric count) and external factors (external environment - exposure to sunlight, wind, rain, cold weather conditions, fabric/human body interaction). These factors affect the performance and behaviour of functional.

Key words: *recovery coefficient**,** fabric count, flotation, creasing, recovery angle after folding*

1. INTRODUCTION

Crease recovery behaviour is an important property of fabrics for apparel applications. Good agreement is observed between experimental data and theoretical predictions for wool/polyester blended and worsted fabrics [1-3]. Based on the semicircular form for a fabric bend, the model established by Chapman and Hearle is improved by considering that bending starts from a finite radius. The relationship between creasing behavior and deformation is deduced and solutions are given for a linearly elastic material with constant internal frictional constraint, and then the improved model is applied to the creasing of semicircular and looped specimens made of different fabrics [4-

6]. Two basic parameters are needed to characterise the fabric in the crease recovery model: the bending rigidity and bending hysteresis of the fabric; both are readily measured in a pure bending test [7]. Agreement between theoretical predictions and experimental results is very satisfactory.

Understanding and predicting the structure and properties of woven textiles is important for achieving specific performance characteristics in various woven applications. Woven textiles are used in a range of products such as apparel, technical and industrial textiles [8-10]. Woven textile structure: theory and applications provides comprehensive coverage of the structure, behaviour, modeling and design of woven fabrics and their relevance to the textile industry [10-13].

Textiles are usually subjected to a wide range of deformations such as bending, folding, creasing, and wrinkling, which may be added deliberately during manufacturing and care or produced by movement of the body during use. Adding wrinkles to a fabric can produce some desirable features as fashionable appearance, usefulness and minimum care. But unintentionally developed, short, irregular wrinkles are unsightly [13].

2. EXPERIMENTAL PART

2.1. Materials and methods

The experimental trials have been performed on a series of woven materials made of **45%Pes+52%Wool+3%Dorlastan,** codified **C1** to **C9**. Factors like fibrous composition, properties of constituent fibers, structural woven parameters, mechanical properties of warp and weft yarns and finishing treatments that influenced the recovery capacity from creasing/folding were investigated such as to assess their importance.

In order to reveal the influence of bonding on the surface characteristics of wovens we have expressed it through the mean flotation F_{warp} for warp yarns and mean flotation F_{weft} for weft yarns. The intersection between a warp yarn and weft yarn is called bonding point, thus the bonding contains all bonding points having a warp or weft effect along a longitudinal or transversal direction. One or more bonding points having the same effect and forming one bonding segment can exist in longitudinal or transversal direction. The bonding segments with the same effect are called flotation (F). They can be warp flotation (F_{warp}) when the warp yarn passes over the weft yarn and weft flotation (F_{weft}) when the weft yarns passes over the warp yarn. The flotation size, similar to the bonding segment, have the minimum value F=1. The following relations exist between the ration (R), number of passes (t) and mean flotation (F):

$$F_{warp} = \frac{R_{weft}}{t_{warp}}\,;\ F_{weft} = \frac{R_{warp}}{t_{weft}} \qquad \textbf{(1)}$$

The measurements are done on woven samples having standard dimensions. These are folded at 180° and pressed along the direction of one of the constituent fiber systems by applying over a defined time interval folding forces which are dependent on the unit surface mass. After the removal of the folding forces, the sample is left to relax freely. The recovery angle is measured in the end of a determined time interval.

The following indicators are for estimating the capacity of textile materials to maintain their initial shape and dimensions during the wearing time:

- **the recovery angle after folding (α) -** the angle between the sample sides folded according to the SR EN 22313:1997 after the removal of the folding force;
- **recovery coefficient λ (%)** calculated according to relation (2):

$$\lambda = \frac{\alpha_1}{180^o}100 \qquad \textbf{(2)}$$

where the recovery coefficient λ can be determined:

-at t_1=1 minute after detension when either λ_1 (%) or the instantaneous recovery coefficient is determined;

-at t_2=10 minutes after detension when either λ_2 (%) or the slow recovery coefficient is determined. The latter is defined by relation (3):

$$\lambda_2 = \frac{\alpha_2 - \alpha_1}{180^o}100 \qquad \textbf{(3)}$$

The total coefficient of recovery after folding is calculated according to relation (4):

$$\lambda = \lambda_1 + \lambda_2 \qquad \textbf{(4)}$$

2.2. Results and discussions

The recovery capacity from creasing depends on the fibrous composition and on the level of deformations. Additionally, also technological processing through mechanical, physical or chemical processes can influence positively or negatively the evolution of the indicator.

Several operations have been performed for each item from the woven materials considered in the study:

-evaluation of the recovery angle after folding (α) and of the recovery coefficient λ (%) along the direction of the two yarn systems, *i.e.* warp and weft. The experimental values are given in Table 1;

-Fig.1 and Fig. 2 are illustrating the plots of functions α and λ by considering the woven materials grouped based on their flotation size.

Following useful observations for the design of woven materials can be drawn based on the analysis of the values in Table 1 and on their graphical representation:

- the largest value of the recovery angle was recorded for the wovens having the average flotation F=2 trialed along the warp direction. These were followed by wovens with same flotation value but along the weft direction;

- by reducing the flotation the recovery angle decreases while the recovery coefficient increases;

- while the yarns diameter increases the recovery angle decreases;

-these types of materials have the highest value of recovery angle after the bending of the direction of the weft threads as they have in their composition the Dorlastan monofilament yarn.

For example, article C3 : α_{weft} =179,6^o and α_{warp} =172,2^o with $Nm_{warp}=Nm_{weft}$=52/2, $P_{warp}>P_{weft}$, with bonding $D\frac{2}{2}/$ so the average float is F=2. For the same article, it may be found that the differentiation on the technological axes, capacity to recover from the creasing on weft axis is larger than the resilience of the crease on the warp direction (axis). For example, article C2 α_{warp} =160,2^o and α_{weft} =172,2^o, with ($Nm_{warp}=Nm_{weft}$=60/2, $P_{warp}>P_{weft}$), canvas armure, so having the average float, F=1.

***Table 1**: Evaluation indicators for assessing the creasing behavior of the studied wovens*

Cod Art.	Bonding	Yarn count Nm		Flotation		Recovery angle from creasing, α		Recovery coefficient from creasing λ	
		Warp	Weft	Warp	Weft	Warp	Weft	Warp	Weft
C1	D2/1	56/2	37/1	1.5	1.5	165	174.2	8.3	3.2
C2	pânza	60/2	60/2	1	1	160.2	175.2	11.0	2.7
C3	D2/2	52/2	52/2	2	2	172.2	179.6	4.3	0.2
C4	D2/1	52/2	52/1	1.5	1.5	164.2	174.5	8.8	3.1
C5	D2/1	56/2	37/1	1.5	1.5	164.1	176.4	8.8	2.0
C6	D2/2	56/2	37/1	2	2	174.6	173.2	3.0	3.8
C7	D2/1	60/2	60/2	1.5	1.5	164.3	174	8.7	3.3
C8	D2/1	60/2	60/2	1.5	1.5	165.2	174.6	8.2	3.0
C9	D2/1	37/1	37/1	1.5	1.5	166.2	171.8	7.7	4.6

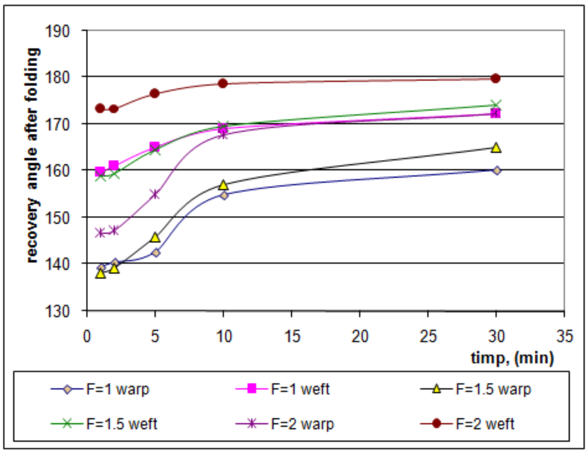

***Fig.1:** Variation of recovery angle after folding from creasing for the studied wovens*

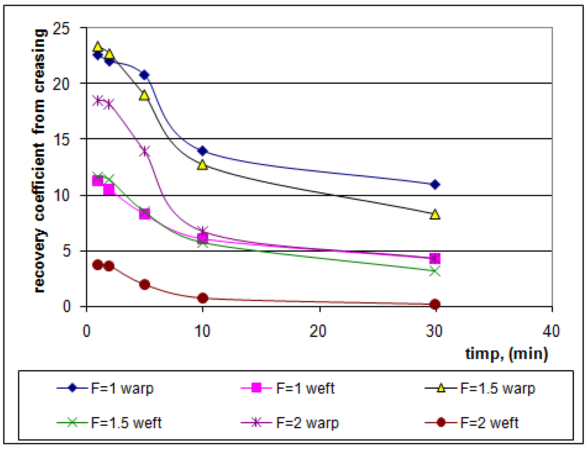

***Fig.2:** Variation of recovery coefficient from creasing for the studied wovens*

Based on the data presented above one can observe that under the standard conditions the recovery angle is higher along the weft yarns direction, which could be because of the following reasons:

- warp yarns fatigue during the weaving process;

- density difference of the two yarn systems;
- different respons of the two yarn systems;
- during the finishing process.

The lowest values of the coefficient of crease recovery were obtained at those sorts of fabric applied in the weft direction, for example: **article C3**, λ_{weft}=0,2, Nm_{warp} 52/2, Nm_{weft} 52/2, $P_{warp}>P_{weft}$, with bonding $D\frac{2}{2}/$.

3. CONCLUSIONS

The creasing of wovens is a complex process of deformation under the action of mechanical stretching, bending and compression strains.

1. Regarding the influence of fibrous composition and the constituent fiber characteristics on the recovery capacity from creasing

The behavior to creasing is determined by the deformability of the constituent fibers with respect to the creasing conditions.

The response at a certain strain level (strain speed, time alternation of application direction, compression or stretching level) is evaluated depending whether the creasing is under or over the elasticity limit of the mentioned strain.

The strain level through creasing determines the total deformation which in turn is determining the ratio between the elastic components of recovery and the remanent deformation value.

2. Regarding the influence of structural parameters on the recovery capacity from creasing

The yarns fineness, technological density and the type of bonding is signficantly influencing the creasing/folding behavior.

The yarns fineness is influencing, at constant structure parameters, the woven thickness. Thus increasing the thickness by increasing the linear density of the used yarns leads to a higher resistance to creasing.

The yarns density is influencing the creasing behavior because the decrease of this parameter leads, independent of the used bonding type, to lower creasing tendency.

The length of flotations has a positive influence on the recovery capacity from creasing.

The simultaneous decrease of yarns density and flotations length parameters leads to a lower fiber tension state of the two yarns systems. This is reflected in the values of the recovery angle. For instance: for yarns with same composition and structure: $Nm_{warp}=Nm_{weft}$=60/2, Item **C2** in Table 1, with P_{warp}=210 yarns/10cm, P_{weft}=205 yarns/10cm, α_{warp}=160,2°, α_{weft}=175,2° and λ_{warp}=11%, λ_{weft}=2,7% , plaine bonding ; Item **C7** in Table 1, with P_{warp}=230 yarns/10cm, P_{weft}=220 yarns/10cm, α_{warp}=164,3° α_{weft}=174° and λ_{warp}=8,7%, λ_{weft}=3,3% , diagonal bonding $D\frac{2}{2}/$.

The plaine bonding presents a low recovery capacity from creasing, thus the flotation increase for both of warp yarns and weft yarns is favorable for reducing the creasing. The effect is compensated because the density in the two yarn systems is different.

3. Regarding the influence of the mechanical properties of warp and weft yarns on the recovery capacity from creasing

Warp yarns are more strained and worn during processing than weft yarns. Thus, even if the two yarns have identical structures, the elasticity module of warp yarns is higher, *i.e*. they become more rigid. This is reflected in lower values of the recovery angle for samples orientated along the warp direction.

Creasing is influenced by increased stiffness during stretching, which is expressed through the elasticity module.

The higher the elasticity module value, the lower is the recovery angle and the higher the creasing recovery coefficient. The interdependence between elasticity module and creasing recovery capacity is illustrated by the experimental data recorded, for instance: Item **C4**, with $Nm_{warp} \neq Nm_{weft}$, $P_{weft}>P_{warp}$, $\alpha_{warp}=164{,}2^{o}$, $\alpha_{weft}=174{,}5^{o}$ and $\lambda_{warp}=8{,}8\%$, $\lambda_{weft}=3{,}1\%$, having the diagonal bonding $D\frac{2}{2}/$, elasticity $E_{warp}=45{,}75$ N/tex, $E_{weft}=28{,}58$ N/tex; Item **C6**, with $Nm_{warp} \neq Nm_{weft}$, $P_{weft}>P_{warp}$, $\alpha_{warp}=174{,}6^{o}$, $\alpha_{weft}=173{,}2^{o}$ şi $\lambda_{warp}=3{,}0\%$, $\lambda_{weft}=3{,}8\%$, having diagonal bonding $D\frac{2}{2}/$, elasticity module $E_{warp}=25{,}62$ N/tex, $E_{weft}=25{,}31$ N/tex.

The present study is also revealing the differentiation, in the frame of the same item, according to technological axis, the recovery angle from creasing along weft direction is higher than the recovery angle along warp direction. When the fineness $Nm_{warp} = Nm_{weft}$, the recovery angle is higher along warp direction and depends on the ration between technological densities and bonding type.

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