STUDY OF THE CREASE REACTION OF THE WORSTED FABRIC TYPES

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Abstract: *In this paper, it was analyzed the crease behavior of the assortments of fabrics made of worsted yarns type for manufacture of clothing. Crease recovery behaviour is an important property of fabrics for apparel applications. 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. By the experimental determinations were revealed the factors which influence the returning capacity from wrinkling/bending of fabric assortments (fibrous composition, component fiber properties, structure parameters of fabrics, mechanical properties of warp and weft yarns and fabric finishing treatments). The measurement is applied to standardized fabric samples and 180 ° bent, pressed in the direction of one of the component yarn systems with mass-dependent bending loads on the surface unit for a specified time. After removing the bending load, the specimen relaxes freely within a specified time interval, then the angle of return is measured. Creasing of a fabric during wear is not change in appearance that is generally desired. The ability of a fabric to resist creasing is in the first instance dependent on the type of fiber used in its construction.*

Key words: *crease behavior, crease recovery angle, woven fabric, curvature, bending of fabric*

1. INTRODUCTION

Creasing is a bending deformation of the fabric and causes an undesirable appearance on the fabric's surface. Physical properties especially bending properties of fibers, fabric construction and finishing processes are three main parameters which affect the crease recovery of fabrics [1, 2, 3]. Fabrics are often subject to repeated creasing and bending deformations, such as elbow movements, and the resilience of crease recovery is an important property that affects fabric's serviceability [4, 5]. Apart from these parameters: twist coefficient, fabric weft and warp yarn densities, fabric thickness are also important parameters related to crease recovery property [6, 7]. Creasing is the result of irreversible changes created through the reciprocal sliding of structural fiber components when exposed to a bending strain. Therefore the woven materials used for garments manufacturing are classified in the following categories:

-reduced creasing, articles type wool;
-average creasing, articles made of synthetic yarns;
-pronounced creasing, articles made of cellulosic yarns that can be improved through

superior finishing [8, 9]. Creasing is specific to oriented structures with high crystallinity (cellulosic fibers) [10]. The sliding appears because of hydrogen bond breaking which can, however, reform easy in other positions conferring a permanent character to creasing [10, 11].

Crease recovery behaviour is an important property of fabrics for apparel applications [11, 12]. A theoretical model is developed in which the fabric is represented by an elastic element and a frictional element. The frictional restraint is assumed to be proportional to the square root of the curvature of the fabric during deformation [13, 14]. An energy method is applied to the study of crease recovery behaviour of the fabric. Equations of crease recovery work and crease recovery force as a function of curvature are derived. 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 [14, 16]. Good agreement is observed between experimental data and theoretical predictions for wool/polyester blended and worsted fabrics. Cotton fabrics take fewer cycles to reach steady than wool fabrics [16, 17, 18]. The high elasticity of polyester fibers affects the resilience remarkably [19, 20].

2. MATERIALS AND METHODS

The study was conducted on woven materials made of combed wool type yarns used for manufacturing outwear clothing, on 12 articles structured as follows. The variation limits of the composition and structural characteristics for the tested woven materials are indicated in table 1.

Table1: *Indicators for assessing the behavior of the Group A fabrics at the request of crease*

Code Art.	Bonding	Yarn count Nm		Recovery angle from creasing, α		Recovery coefficient from creasing λ	
		warp	weft	warp	weft	warp	weft
A1	D2/1	64/2	64/2	149	147	17.2	18.3
A2	D2/1	64/2	64/2	150.1	149.2	16.6	17.1
A3	plain	64/2	64/2	134.6	131.8	25.2	26.8
A4	R 3/1	60/2	60/2	161.2	159	10.4	11.7
A5	D 1/1 2/1 1/5	60/2	60/2	156	153.2	13.3	14.9
A6	plain	60/2	60/2	135.2	130.4	24.9	27.6
A7	D2/2	60/2	60/2	160.5	158.3	10.8	12.1
A8	D4/1	60/2	60/2	165	163.8	8.3	9.0
A9	check	52/2	52/2	144.4	141.6	19.8	21.3
A10	D2/1	52/2	52/2	148.7	146.5	17.4	18.6
A11	plain	52/2	52/2	134.9	132.5	25.1	26.4
A12	D 1/1 1/5	52/2	52/2	161.4	160.7	10.3	10.7

The experimental trials have been performed on a series of woven materials made of 45% wool+55%pes. 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):

$$F_{warp} = \frac{R_{weft}}{t_{warp}} ;\ F_{weft} = \frac{R_{warp}}{t_{weft}} \tag{1}$$

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):

$$\lambda = \frac{\alpha_1}{180^o} 100 \tag{2}$$

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):

$$\lambda_2 = \frac{\alpha_2 - \alpha_1}{180^o} 100 \tag{3}$$

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

$$\lambda = \lambda_1 + \lambda_2 \tag{4}$$

The bending property is one of the most significant properties in fabric handling evaluation, affecting fabric drape, crease resistance, garment formability, and other performances.

3. EXPERIMENTAL PART

The bending properties of a fabric are dependent on the mechanical properties of fibres, the structure of yarns, as well as the weave and finishing of the fabric. 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(t) and λ(t) by considering the woven materials grouped based on their flotation size.

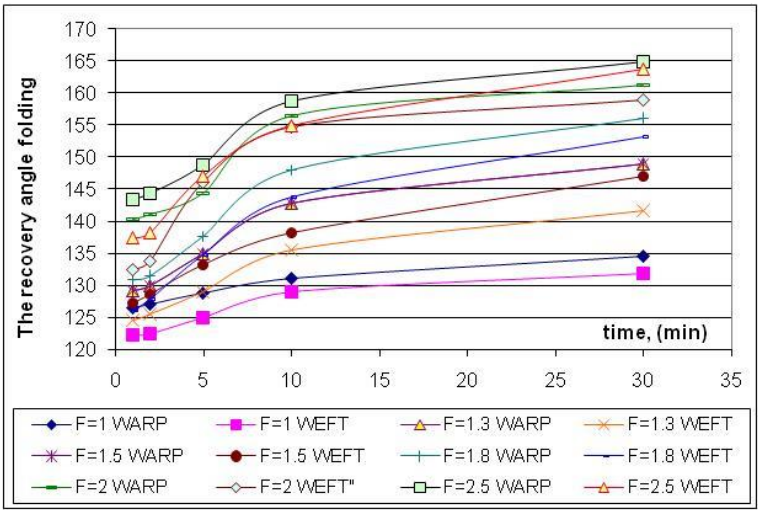

***Fig.1.** Variation of return angle after bending, for the Group A studied fabric assortments*

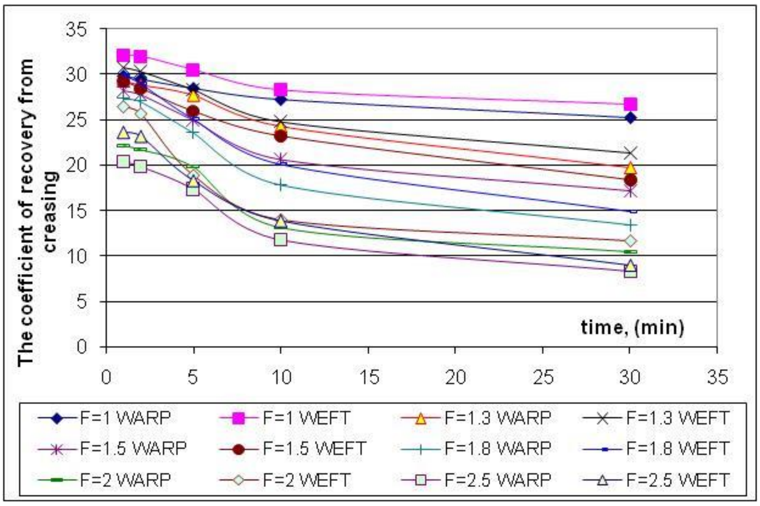

***Fig.2.** The variation coefficient of recovery from creasing for the Group A fabrics*

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 fabric assortments in this group have the lowest value of the return angle after bending, the values are higher in the direction of the warp threads than in the direction of the weft yarns, all the fabrics in this group are balanced to fines and unbalanced to the width, and in this group, it is noted that, for example, as flotation increases, the angle of return after bending decreases: Art. A8, α_{weft} =164.2° and α_{warp} =165.4° with (Nm_{warp}=Nm_{weft}=60/2, P_{warp}>P_{weft}), linen D $\frac{4}{1}$/ so the average float F=2.5 and Art. A3 α_{warp} =134.2° and α_{weft} =130.5°, with $Nm_{warp}=Nm_{weft}=64/2$, $P_{warp}>P_{weft}$, canvas linen, so the average float F=1.

Also creasing cause damages on fabric, because abrasion occurred along the crease. Creasing recovery is the ability of a fabric to recover from folding deformations and return to original appearance as much as possible. This ability also improves the aesthetic view and easy-care properties of the fabrics and also affects the performance of end product. The performance of fabrics under most service conditions depends largely on their bending behaviour.

4. CONCLUSIONS

An energy method is applied to the study of crease recovery behaviour of the fabric. Equations of crease recovery work and crease recovery force as a function of curvature are derived. 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. Good agreement is observed between experimental data and theoretical predictions for wool/polyester blended and worsted fabrics.

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

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