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BAGGING BEHAVIOUR OF EXTENSIBILE SHIRT FABRICS

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Abstract: *Fabric bagging is a type of three dimensional permanent deformations of garments that occurs at positions such as elbow and knee. When a prolonged compression force is exerted on a garment during wear, the three dimensional deformation may involve complex inelastic behaviour in the garment, including viscoelastic behaviour of the fibers and plastic behaviour due to frictional movements between fibers and between yarns in the fabric.*
The aim of this stduy is to engineer extensibilty values of shirt fabrics along weft direction and hence to analyze and interpret the bagging behavior of extensible shirt fabrics in terms of fabric mechanical preoperties.
In this study, finished extensible plain woven shirt fabrics with changing the core-spun extensible yarn layout along weft direction were produced. The bagging behavior of samples tested at a speed of 7 (mm/min) and initial bagging height 7(mm) in 5 successive cycles using an Instron tensile tester equipped with 4 circular clamps in 56, 61, 66 and 71 (mm) diameter. The results were then statistically analysed using ANOVA test method.
The statistical analysis results show that fabric extensibility along weft direction and sample diameter has a statistical significant effect on bagging behaviour of extensible shirt fabrics. It is indicated with the increase in fabric extensibility and sample diameter the bagging parameters are significantly decreased.

Key words: *Sample diameter, Fabric bagging, Weft extensibility. Garment deformation.*

1. INTRODUCTION

Fabric bagging is a type of three dimensional permanent deformations of garments that occurs at positions such as elbow and knee [1] and it is often being considered as an aesthetically undesirable deformation. It has been assumed that when a prolonged compression force is exerted on a garment during wear, the three dimensional deformation may involve complex inelastic behaviour in the garment, including viscoelastic behaviour of the fibers and plastic behaviour due to frictional movements between fibers and between yarns in the fabric [1,2].

The subject of bagging has been studied by many researchers both theoretically and experimentally [1-10] in which a comprehensive survey of this subject are given elsewheres [2,8,9]. Besides of the fabric aesthetic properties, the clothing comfort during usage of the apparel is also important. Woven fabrics containing elastane yarns, due to their enhanced elastic properties such as increased extensibility, elasticity, high degree of recovery, and good dimensional stability, have wide applications in which the comfort properties in wear are of the main concern. In recent years, in order to reduce permanent bagging deformation in different parts of the body; extensible and high elastic recovery fabrics have been introduced. There are little studies however on bagging behavior of extensible fabrics. In particular, Ozdil [6] investigated the bagging behavioiur of denim fabrics

containing different rates of elastane along weft direction using a bagging tester based on the artificial arm with an elbow joint. The results showed that with an increase of elstane content in the fabric, permanet bagging decreases, whereas elastic bagging increases. The aim of the current study is to engineer extensibilty values of shirt fabrics along weft direction and hence to analyze the bagging behavior of extensible shirt fabrics tested with a previously developed method by the author [5,7,8].

2. MATERIAL

In this work, 4 extensible finished woven cotton shirt fabrics (plain weave design, weft density 27 cm^{-1} and warp density 47 cm^{-1}), with changing the extensible yarn layout along weft direction were prepared [10] as shown in Figure 1. Warp yarn was cotton ring-spun yarn (15 tex). Two different weft yarns namely normal cotton ring-spun yarn and elastic core-spun cotton yarn with the same linear density of 20 tex were used. Fabric thickness and weight were measured as 0.28 (mm) and 124 (g/m^2) respectively. To quantify fabric elasticity, a similar factor to FAST index [11] (E100), here named as fabric extensibility, was defined as the fabric extension at the load of 100 (N/m) in the weft direction.

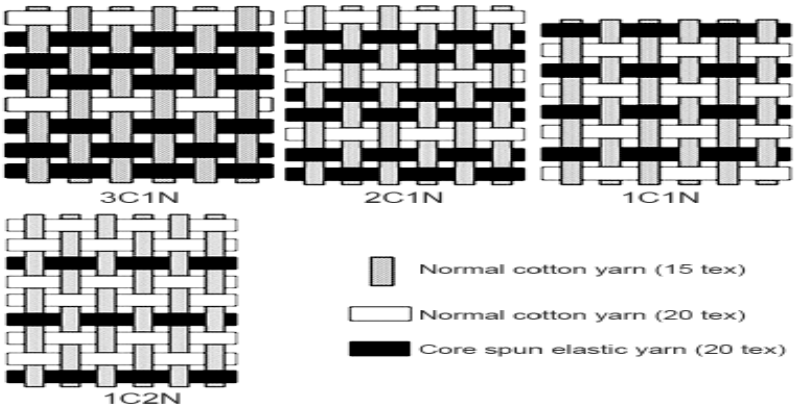

Fig. 1*: Schematic views of woven fabric structures[10].*

3. FABRIC BAGGING TESTING

Bagging test is performed on an Instron 5566 tensile tester (Figure 2) using a previously developed method by the author [5,7,8]. A steel ball (sphere) with a diameter of 48 mm is attached to the upper jaw of tensile tester. The fabric samples with diameter of 61, 68, 71, and 78 mm respectively is placed in a corresponding circular ring with inner diameter of 56, 61, 66, and 71 mm. The crosshead speed and the bagging height were set at 7 mm/min and 7 mm values respectively. All tests were initiated under a preload of 0.1 (N) pressure force and for each fabric sample, the cyclic loading was performed 5 times and 5 tests were investigated. The maximum load and corresponding work of loads and hysteresis percentage at the first and last cycles are calculated, and then residual bagging height, bagging fatigue, bagging resistance, bagging hysteresis, and residual bagging hysteresis are calculated [3,7]. All experiments were carried out under the standard conditions. The results were statistically analysed by ANOVA test method.

***Fig. 2**: A photograph of the fabric bagging tester.*

4. RESULTS AND DISCUSSION

ANOVA Statistical analysis results for bagging parameters are briefly summarized in Table 1. The statistical analysis results indicate that both fabric extensibility and sample diameter significantly influenced the fabric bagging properties.

***Table 1:** ANOVA statistical analysis results for bagging parameters (P- value= 0.05).*

Parameters	**Weft extensibility**	**Sample diameter**	**Weft extensibility*Sample diameter**
Bagging force at the first cycle loading	0.00	0.00	0.00
Bagging force at the 5th cycle loading	0.00	0.00	0.00
Bagging resistance	0.00	0.00	0.00
Residual bagging height	0.00	0.00	0.00
Bagging hysteresis	0.00	0.00	0.00
Residual bagging hysteresis	0.00	0.00	0.00
Bagging fatigue	0.00	0.00	0.00

Typical results are depicetd in Figures 3 and 4. It is shown that with increase of fabric extensibility residual bagging height and bagging fatigue decrease. Similar trend results are obtained for other bagging parameters particularly bagging resistance and maximum bagging load. As shown in 'Figure 3', fabric with lower extensibility value, exhibits higher residual bagging height value. In fabric with higher bagging force, recovery to the initial state is lower hence residual bagging height is high. As also depicted in 'Figure 3', with increasing fabric sample diameter, the residual bagging height is significantly decreased. Sengoz [1] also indicated that increasing the circular and square

frames dimension resulted to a lower residual bagging height value. It is observed that with increase of fabric extensibility, fabric tensile elastic modulus decreases which in turn leads to a lower resistance against bagging deformation. On the other hand, with increase of sample diameter and hence a lower ball to sample diameter ratio, a lower tensile membrane strain [4] and as a result a less resistance against bagging deformation is obtained which results to a significant reduction of bagging parameters.

The bagging fatigue process is related to the elastic and viscoelastic properties of fabric. As shown in 'Figure 4', with increasing fabric extensibility, stress and frictional forces between yarns decrease, hence bagging fatigue percentage decrease. Also bagging fatigue percentage significantly decreased with increasing sample diameter. This result is attributed to the lower bagging force and hence lower elastic stored energy at higher sample diameter level (lower ball to sample diameter ratio) [4].

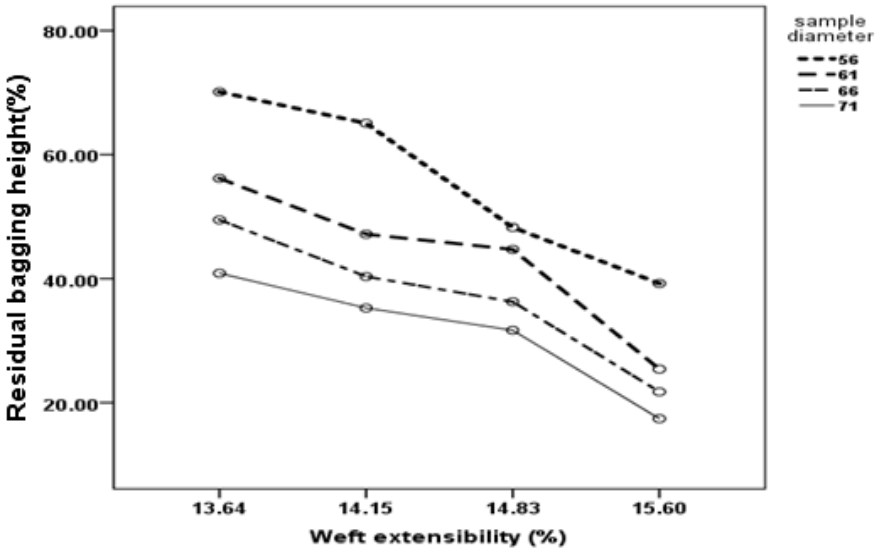

***Fig. 3**: Effect of weft extensibility and sample diameter on residual bagging height.*

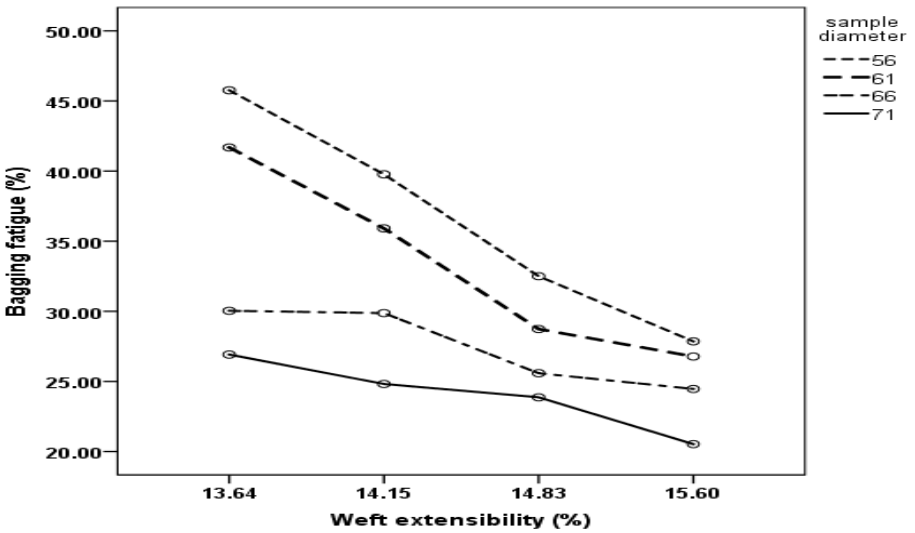

***Fig. 4**: Effect of weft extensibility and sample diameter on bagging fatigue.*

5. CONCLUSIONS

The aim of this work was to investigate the effects of fabric extensibility and sample diameter on bagging behaviour of extensible shirt fabrics. Finished extensible plain woven shirt fabrics with changing the core-spun extensible yarn layout along weft direction were produced and then the bagging properties of samples were obtained at four different sample diameter of 56, 61, 66 and 71 (mm). The results were then statistically analysed using ANOVA test method.

The statistical analysis results show that fabric extensibility along weft direction and sample diameter has a statistical significant effect on bagging behaviour of extensible shirt fabrics. The results revealed that with the increase in fabric extensibility the fabric tensile strength and modulus decreased which causes the bagging parameters to be decreased. This result is mainly attributed to the higher tensile elastic recovery with increasing fabric extensibility. The results also show that with increasing sample diameter in bagging testing different bagging parameters due to the decreasing ball to sample diameter ratio significantly decreased. The obtained results of this research suggest that the in-plane fabric tensile properties play a major role in bagging behaviour of extensible woven fabrics.

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