TWIST DIRECTION AND YARN TYPE EFFECT ON DRAPING PROPERTIES

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ABSTRACT

Regarding fabric behavior, drape measurement has always been one of the main interests to simulate real wear situation and therefore has been studied profoundly. The cantilever test, the FRL fabric drape meter and well-known Cusick's drapemeter is the important milestones in drape testing while different approaches have been introduced more recently. Due to the increasing applications in design, product development and e-commerce in recent years and even stretching its application in movie-animation industry nowadays, digital measurement of fabric drape has attracted more attention together with the developments in computer sciences.

In this multinational study, special fabrics having specific yarn and fabric parameters were produced and tested for their drape characteristics. In this respect, 100% cotton fabric samples were woven by using warp and weft yarns of different twist directions (S or Z) spun from the same raw material to understand the effect of twist directions on fabric drape behavior in static and dynamic state. The tests were carried out on Sylvie 3D Drape-Tester which includes a 3D laser scanner and a step-motor based fabric laying mechanism. The findings indicate that twist directions of warp and weft yarns of fabrics affect drape behavior significantly both in static and dynamic case, and this was mainly explained by the effect of untwisting moments and inter-yarn frictions in draped fabric.

Key Words: *Fabric drape, drape tester, twist direction, dynamic drape*

1.INTRODUCTION

Fabric drape measurement is an important tool for understanding fabric appearance in real wear conditions and simulation of fabric appearance. There are several methods used in this field as cantilever method (Peirce, 1930) was used to predict drape behavior of fabrics in the beginnings and FRL drape meter was developed by Chu et. al for measurement of fabric drape in three dimensional state (1950) later on. However, the Cusick method, developed by Cusick (1968), has been the one used for years traditionally while improvements have been carried out for a faster, precise and accurate drape measurement based on Cusick tester principle (Collier,1991; Ji, 2005; Kyu, 2004; Kenkare, 2005; Tamas, 2006; Pandurangan, 2008) and there are some other alternative methods to Cusick's tester as well (Hes, 2001).

Apart from static drape, the measurement of drape in dynamic state has gaining importance in terms of real-wear simulations as there are different approaches have been introduced by various studies (Stylos and Zhu;1997; Yang and Matsudaira, 1999; Mizutani et al., 2005; Shry et al., 2007).

Although the drape behavior of fabrics is a complex phenomena, it is well known that this behavior depends on the state of fabric hanging, various fabric parameters, the surface structure of the holder on which the fabric laid on, environmental factors and so on. In literature, there are various studies focused on the interactions between fibre, yarn and fabric parameters in terms of drape behavior. The correlation between fabric mechanical properties and drape was studied extensively as one of the earlier studies was reported by Niwa and Seto (1986). There are various other studies focused on the relationship between fabric and yarn properties and drape (Mohammed et al., 2000; Shyr et al., 2007; Gersak, 2004; Kokas, 2005; Yuan et al.,2006).

Different from the above works, in this study we wanted to understand the main effect of some yarn parameters, especially the twist direction of warp and weft yarns, on drape behavior in both static and dynamically influenced drape conditions. The results below revealed interesting findings.

2. EXPERIMENTAL

For studying the effect of twist direction, special fabric samples were produced having specific yarn and fabric parameters. In the design of experimental fabrics, the twist direction in weft and warp way (both warp and weft is in Z or S, or warp is in Z but weft is in S twist) was arranged in a specific way. We also produced fabrics from OE-rotor yarn and ring carded yarn to observe the effect of yarn type. The yarns were spun form the same raw material. The fabric properties are given in Table 1. As seen from the data below, T1, T4 and T5 fabrics have common properties except the twist direction of their yarns in warp and weft wise.

Table 1. Fabric particulars

Fabric Code		Yarn type	Nominal Yarn Count	Nonimal Twist T_m [t/m]	α_e	Density [yarn/cm]		Weave type
						Nominal	Actual	
T1	Warp	Ring- Combed	Ne 30/1	845/Z	3,9	26	27	Plain
	Weft	Ring- Combed (RC-2)	Ne 30/1	845/S	3,9	26	27	
T2	Warp	OE-Rotor	Ne 30/1	840/Z	3,9	26	29	Plain
	Weft	OE-Rotor	Ne 30/1	840/Z	3,9	26	27	
T3	Warp	Ring- Carded	Ne 16/1	619/Z	3,9	24	26	Plain
	Weft	Ring- Carded	Ne 16/1	619/Z	3,9	24	26	
T4	Warp	Ring- Combed	Ne 30/1	845/Z	3,9	26	29	Plain
	Weft	Ring- Combed	Ne 30/1	845/Z	3,9	26	29	
T5	Warp	Ring- Combed	Ne 30/1	845/S	3,9	26	27	Plain
	Weft	Ring- Combed	Ne 30/1	845/S	3,9	26	27	

2.2. Fabric Drape Tests

The drape tests were carried out on Sylvie 3D Drape Tester, which is developed at Budapest University of Technology and Economics. The basic principle of the equipment is mainly similar to the Cusick fabric drape tester while the fabric drape analysis were carried out by laser beams-camera and a computer programme. During the tests, the circular fabric samples of 300 mm diameter are placed on the sample holder having 180 mm diameter and drape coefficient is measured as described earlier (Tamás, 2006). Five measurements were done for each fabric type. In addition to the traditional measurement, the dynamic strain imposed on fabrics in real wear also simulated in this study by addition of rings into the testing system having diameter D210mm. By the dynamically influenced measurement, the equipment push the fabric sample through the ring. The rings were positioned at 100mm above of the base where sample holder was moved 300mm upwards at 25mm/sec speed.

2.3 KES-FB system

For testing of low stress mechanical and surface properties of fabrics, Kawabata fabric evaluation system, KES-FB is used to test fabric extension, shear, bending, compression behavior, surface friction and roughness.

3. TEST RESULTS AND ANALYSIS

3.1. KES-FB Test Results

The detailed test results regarding mechanical and surface properties of the fabric specimens are given below as average values obtained during the tests are compared (Figure 1).

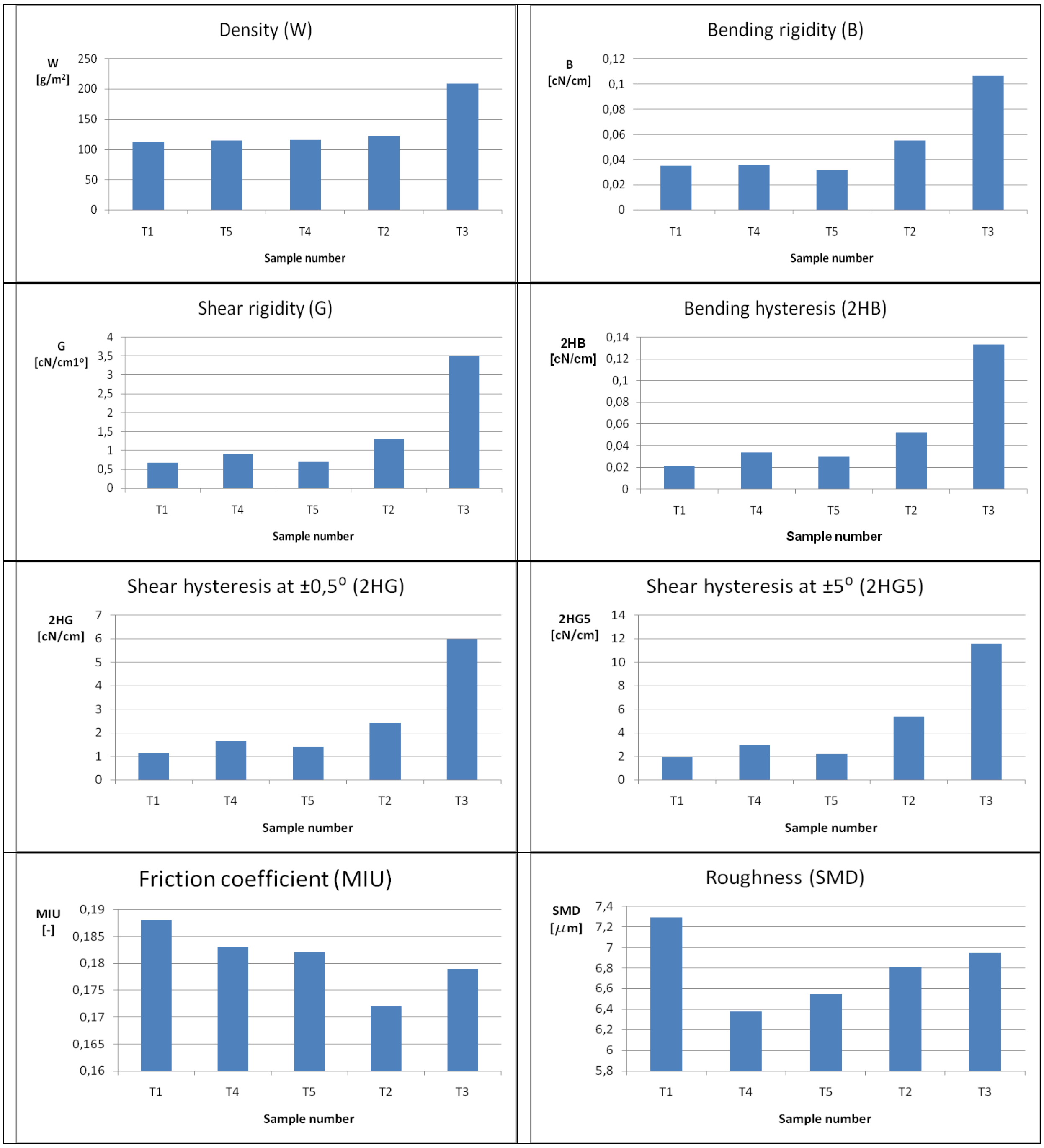


Figure 1. The comparison of average values obtained by KES-FB tests

3.2 Drape Test Results in Static and Dynamically Influenced State

The dynamically influenced drape test results, which indicates the effect of dynamic strain to simulate the real wear situations, are given in Figure 2 in comparison with the traditional static drape values.

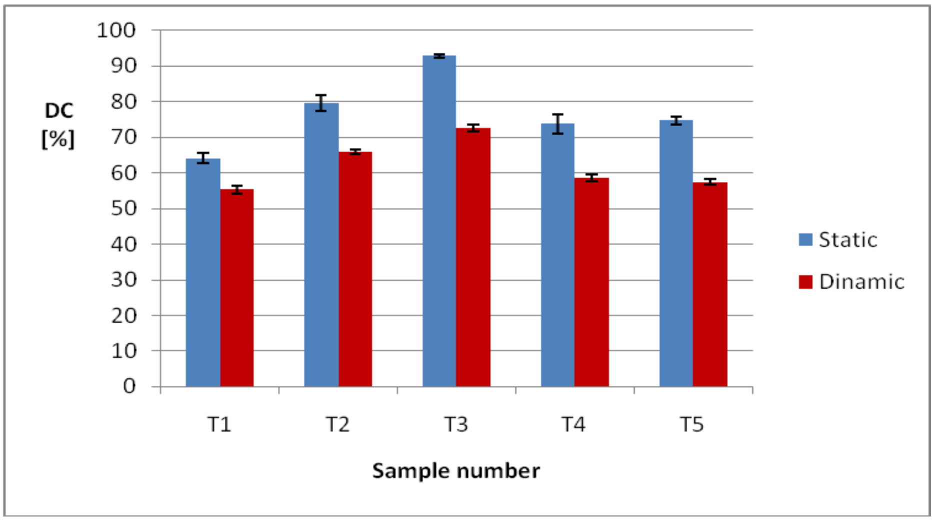
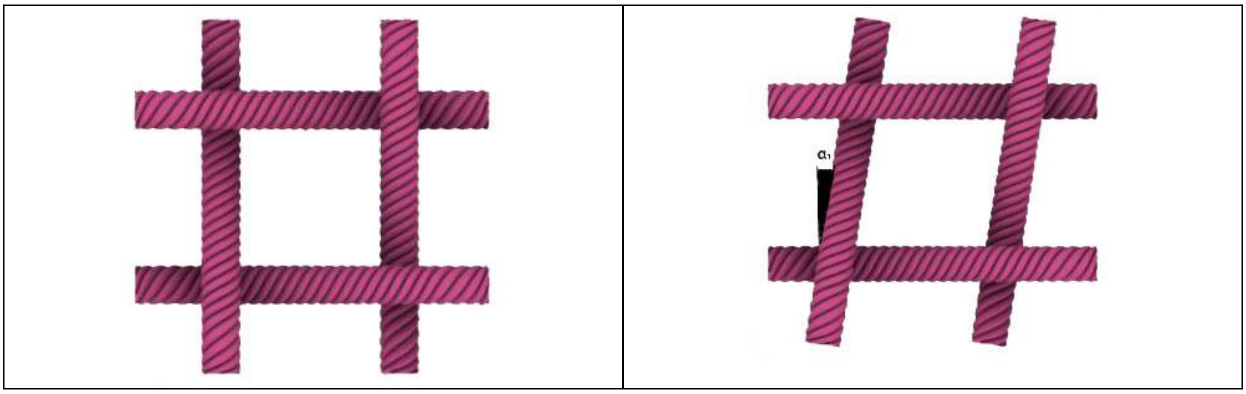


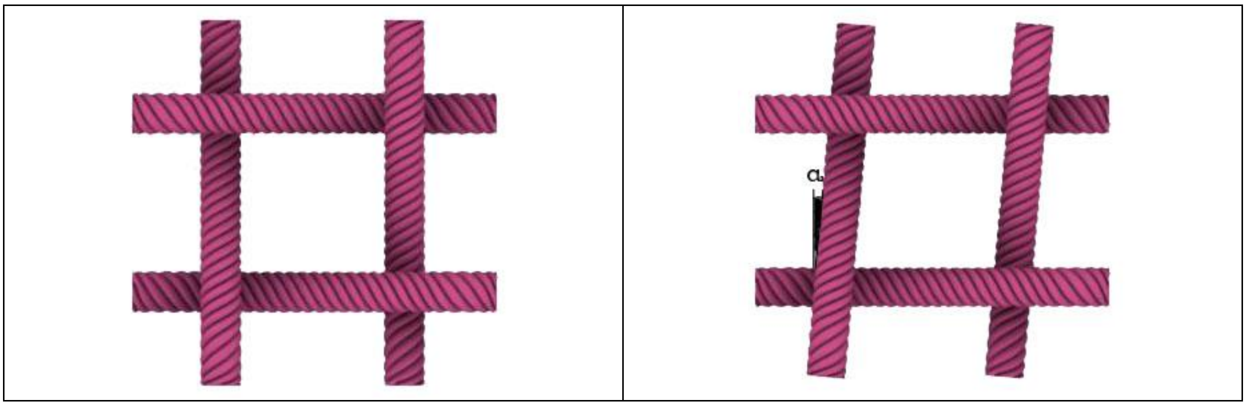
Figure 2. Drape coefficient in static state and its change in dynamically influenced state

3.3 The Effect of Twist Direction

As indicated above, three fabric samples (T1, T4 and T5) were produced to observe the effect of twist direction in both weft and warp way. The test results in Figure 2 clearly show the effect of twist direction on drape coefficient. When we compare the results of these three fabrics, the two fabric specimens (T4 and T5) exhibit similar behavior while T1 fabric is the most drapable one among these three fabric sample, i.e. has the lowest DC value. The reason for that can be the internal balance in its own strain when the specimen is draped due to the effect of untwisting moments in draped form during the tests. This behavior can be explained by considering the direction of untwisting moments in its weft and warp yarns.



a) T1 fabric structure: Warp Z twist, weft S twist



b) T4 Fabric structure: Warp Z twist, weft Z twist

Figure 3. Schematic representation of shear behavior between warp and weft yarns of T1, T4 and T5

When KES-FB test results are examined, we can see that both the bending and the shear rigidity and hysteresis of sample T1 is smaller compare to the samples of T4 and T5. We consider that this can be due to the effect of inter-yarn friction property of weft and warp yarns. In other words, when there is less inter-yarn friction between warp and weft yarns as might be the case in T1 fabric, it might be easier to observe higher shear leading to a higher drapeness. Such a simple interaction leading to higher/lower shear between warp and weft yarn in relation to twist direction was depicted in Figure 3.

The test results also show that twist direction influences the fabric surface properties as expected. The surface of the fabrics woven from the yarns with same twist direction is more smooth and has smaller friction values. With T1, it is clear that different twist direction in weft yarn creates a rougher surface. On the other hand, the surface roughness and friction was found as the highest for T1 compare to T4 and T5, but the drape test results indicated that this did not have any effect on drape behaviour.

3.4 The Effect of Yarn Type

The results above show that the fabric T3, which produced from the coarser and carded yarn, has the highest bending rigidity while T2 fabric of OE-rotor spun yarn comes next. Same trend is valid for shear rigidity too. Similar behavior can be observed in bending and shear hysteresis.

The results above show that T2 fabric, which has the same yarn and fabric parameters but produced from OE-rotor yarns, has higher drape coefficient, therefore less drapable as expected due to the different yarn structure. Therefore we can conclude that this fabric exhibits different drape behavior compare to T1, T4 and T5 fabrics. On the other hand, the fabric of carded ring spun yarn (T3) has the highest drape coefficient, so the least drape. The main reason for this is the yarn count as it is coarsest one compare to the other specimens.

When we compared the surface properties of T1, T4 and T5, the sample T1 has highest friction coefficient and roughness while the sample T2 and T3 have lowest values. On the other hand, when we compared the results of fabrics produced from combed ring yarns and OE-rotor yarns, the inherited yarn structures are well-known, the surface of combed yarn is smoother and has more compact structure in opposite to the OE-rotor yarn. Evidently the friction between the combed yarn is expected to be much smaller compare to the OE-rotor and carded yarns.

4. CONCLUSIONS

The results carried out in this work show that twist direction within a fabric influences fabric drape significantly as the fabric having different twist direction in warp and weft way (Z and S twist, respectively) has lowest drape coefficient compare to the fabrics having same twist direction in both ways (Z or S twist). We believe this result is an original contribution for a better understanding of drape behavior of fabrics.

Similarly, the difference between static and dynamically influenced drape is the lowest one for the fabric of different twist directions at warp and weft side. This is explained by the high friction between the warp and weft yarns of these fabrics resulting less inter-yarn movement during dynamically influenced drape.

We also observed that drape of fabrics produced from OE-rotor yarns is much less as might be well expected due to the irregular surface and harsh feelings of these yarns.

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