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FABRICS MADE FROM NON-CONVENTIONAL BLENDS: WHAT CAN WE EXPECT FROM THEM RELATED TO HANDLE

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The paper briefly describes a novel patented laboratory instrument, which was investigated, designed and manufactured at the University of Minho based on a new method of accessing friction coefficient of fabrics, as well as its fundamentals and working principle, followed by an experimental study, where a comparison between three different double-faced fabrics made from non-conventional fibre combinations was carried out, the results of the experimental work being analyzed using various tools, including SPSS15.0® statistical package and commented in the light of the influence of the raw material in the friction properties of the fabrics.

Introduction

Interaction with the human senses is an essential performance property [1, 2] as most textile materials are used near the skin, namely clothing, home furnishings and automotive fabrics. Friction coefficient is one of the factors contributing for the so-called parameter *fabric hand* and its importance justifies the number of contributions given in the past to this problem [3-7]. More recently, novel laboratory equipment was proposed for a new method of friction coefficient assessment of fabrics, which is easy to use and very precise. The development and validation of FRICTORQ [8] justifies an experimental work with a set of fabrics made from non-conventional fibre combinations. These new materials reflect the main present fibre research where new mixtures are used to reduce environmental impact, improve material performance and diversify the use of raw materials.

PLA (Polylactic-acid) is one of the new fibres used in the evaluated mixtures. Its main advantages are as follows: cotton look appearance; environmental friendly, based on a natural polymer thus biodegradable; high resistance to UV [9]. When mixed with other fibres [10] PLA also shows a good performance, namely:

- Natural fibre hand;
- Wickability / breathability of natural fibres;
- Good performance qualities;
- Good flammability resistance;
- Excellent drapeability.

SPF (Soya Protein Fibre) is also another new fibre used in this work. It is made by a wet spinning process occurring after the extraction of spherical protein from soybean residue. One of the most attractive properties of SPF is the soft touch as well as a good moisture absorption giving fabrics better comfort properties when mixed with other fibres [11].

The model of Frictorq

This model went through various development stages and some of the detected weaknesses suggested that a different approach could be explored [12, 13].

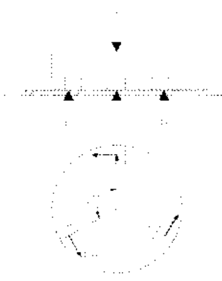

Figure 1. FRICTORQ II model

Figure 1 is a schematic representation of the latest adopted model named FRICTORQ II. The laboratory prototype of the instrument is represented in figure 2. For a more complete understanding, references [12, 14] present and discuss other models and design stage details for the development of the present prototype, including a fabric-to fabric initial proposal that is still valid and can easily be an alternative in this instrument.

Figure 2. FRICTORQ II laboratory prototype

The rotary action remains, but the contact is now restricted to 3 small special elements or feet, disposed at 120°. Providing a relative displacement of approximately 90°, it is assured that a new portion of fabric is always moved under the contact sensors. For this model, torque is given by:

$$T = 3\, F_a\, r$$

(1)

Being, by definition, $F_a = \mu N$ and from figure 1, N = P/3, where P is the vertical load, the coefficient of friction is then expressed by:

$$\mu = \frac{T}{P \times r}$$

(2)

Previous exploratory work led to the establishment of some design parameters, namely contact pressure and linear velocity in the geometric centre of each contact foot, the latter set to approximately 1,57 mm/s.

Figure 3 represents a graphic display of an experiment showing the most relevant parameters. The shape of the graph is stable and nearly horizontal for the duration of the test. For dynamic friction the data collected between 5 and 20 seconds of the test is used.

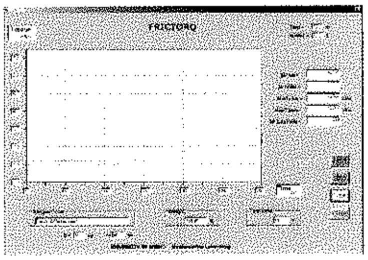

Figure 3. Graphical output representation of a typical fabric friction experiment

As well as other well known methods, such as KES, this one is not covered by any standards. The contact surface is made of standard and commercially available steel needles of 1 mm diameter joint side by side in a square shape as it is seen in figure 1. Therefore this surface is well characterized and easily reproducible.

Experimental Procedure

iii. Characterization of the Tested Materials

The tested materials were three double-faced fabrics made from non-conventional fibre combinations listed as follows:

1) Cotton – Corn fibre (CO-PLA);
2) Polyester/Cotton – Cotton (PES/CO-CO);
3) Cotton – Soya fibre (CO-SPF).

These double faced fabrics have the same construction weave in both sides, based in a 5- satin structure. The difference between the two faces lay on the weft material, e.g. in cotton- corn fibre the outer face (OF) in mainly composed by cotton while the inner face (IF) is mainly made by Corn fibre. The use of these double faced structures allowed us to test the influence of each fibre in friction properties.

jjj. Methodology

FRICTORQ II instrument was used to test the outer-face (OF) and inner-face (IF) surfaces of the mentioned materials. Samples were prepared and cut in circles of 130 mm diametre and tested under a conditioned atmosphere of 20 ± 2 °C and 65 ± 2 % RH.

Results and Discussion

After collecting the data obtained during the tests carried out using Frictorq testing apparatus, a statistical package SPSS15.0® was used in order to analyse the influence of the different materials in the friction coefficient. Table 1 shows the results obtained in the descriptive statistics for friction coefficient of the tested materials.

Table 1 Descriptive statistics

	N	Mean	Std Deviation	Std Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower boundary	Upper boundary		
CO-PLA_IF	13	,195785	,0035090	,0009732	,193664	,197905	,1911	,2050
PES/CO-CO_IF	13	,207169	,0035382	,0009813	,205031	,209307	,2027	,2133
CO-SPF_IF	13	,204500	,0035744	,0009914	,202340	,206660	,1975	,2108
CO-PLA_OF	13	,197215	,0022623	,0006275	,195848	,198582	,1923	,2011
PES/CO-CO_OF	13	,206200	,0023241	,0006446	,204796	,207604	,2029	,2107
CO-SPF_OF	13	,211638	,0042068	,0011668	,209096	,214181	,2043	,2184
Total	78	,203751	,0064628	,0007318	,202294	,205208	,1911	,2184

As can be verified in table 1, the mean values range is between 0,195785 and 0,21638, with the minimum value obtained for CO-PLA_IF and the maximum for CO-SPF_OF. In figure 4 the results obtained from the test are presented in a box-plot chart.

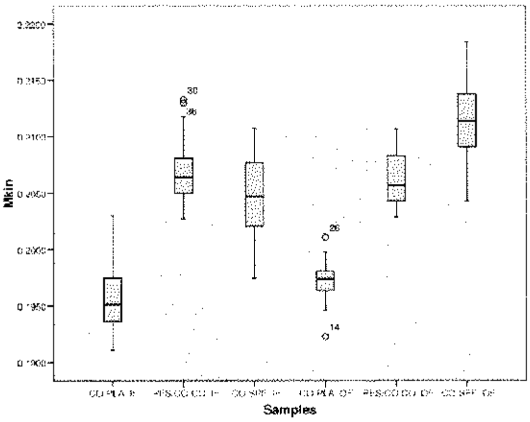

Figure 4. Box-plot results

The lowest amplitude value is achieved when the CO- PLA_OF sample was tested and the highest for the CO-SPF_OF. In order to compare the results obtained from the six tested materials a Scheffe analysis was carried out as to determine the existence of homogeneous subsets. Means for groups in homogeneous subsets are displayed in table 2.

Table 2. Scheffe analysis for μ_{kin}

Samples	N	Subset for alpha = .05		
		1	2	3
CO-PLA_IF	13	,195785		
CO-PLA_OF	13	,197215		
CO-SPF_IF	13		,204500	
PES/CO-CO_OF	13		,206200	
PES/CO-CO_IF	13		,207169	
CO-SPF_OF	13			,211638
Sig.		,942	,523	1,000

a Uses Harmonic Mean Sample Size = 13,000.

The analysis clearly determines the existence of three different subsets. In order to analyse with precision the results obtained in the Scheffe test, the multiple comparisons table 3 was carefully reviewed. This brought to our attention the significance obtained between CO-SPF_OF and PES/CO-CO_IF which is 0,048, near the 0,05 level of significance in which the test is carried out.

Table 3. Multiple comparison analysis for μ_{kin}

(I) Samples	(J) Samples	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Upper Bound	Lower Bound
CO-PLA_IF	PES/CO-CO_IF	-,0113846(*)	,0012992	,000	-,015830	-,006939
	CO-SPF_IF	-,0087154(*)	,0012992	,000	-,013161	-,004270
	CO-PLA_OF	-,0014308	,0012992	,942	-,005876	,003015
	PES/CO-CO_OF	-,0104154(*)	,0012992	,000	-,014861	-,005970
	CO-SPF_OF	-,0158538(*)	,0012992	,000	-,020299	-,011408
PES/CO-CO_IF	CO-PLA_IF	,0113846(*)	,0012992	,000	,006939	,015830
	CO-SPF_IF	,0026692	,0012992	,523	-,001776	,007115
	CO-PLA_OF	,0099538(*)	,0012992	,000	,005508	,014399
	PES/CO-CO_OF	,0009692	,0012992	,990	-,003476	,005415
	CO-SPF_OF	-,0044692(*)	,0012992	,048	-,008915	-,000024
CO-SPF_IF	CO-PLA_IF	,0087154(*)	,0012992	,000	,004270	,013161
	PES/CO-CO_IF	-,0026692	,0012992	,523	-,007115	,001776
	CO-PLA_OF	,0072846(*)	,0012992	,000	,002839	,011730
	PES/CO-CO_OF	-,0017000	,0012992	,885	-,006146	,002746
	CO-SPF_OF	-,0071385(*)	,0012992	,000	-,011584	-,002693
CO-PLA_OF	CO-PLA_IF	,0014308	,0012992	,942	-,003015	,005876
	PES/CO-CO_IF	-,0099538(*)	,0012992	,000	-,014399	-,005508
	CO-SPF_IF	-,0072846(*)	,0012992	,000	-,011730	-,002839
	PES/CO-CO_OF	-,0089846(*)	,0012992	,000	-,013430	-,004539

	CO-SPF_OF	-,0144231(*)	,0012992	,000	-,018869	-,009977
PES/CO-CO_OF	CO-PLA_IF	,0104154(*)	,0012992	,000	,005970	,014861
	PES/CO-CO_IF	-,0009692	,0012992	,990	-,005415	,003475
	CO-SPF_IF	,0017000	,0012992	,885	-,002746	,006146
	CO-PLA_OF	,0089846(*)	,0012992	,000	,004539	,013430
	CO-SPF_OF	-,0054385(*)	,0012992	,007	-,009884	-,000993
CO-SPF_OF	CO-PLA_IF	,0158538(*)	,0012992	,000	,011408	,020299
	PES/CO-CO_IF	,0044692(*)	,0012992	,048	,000024	,008915
	CO-SPF_IF	,0071385(*)	,0012992	,000	,002693	,011584
	CO-PLA_OF	,0144231(*)	,0012992	,000	,009977	,018869
	PES/CO-CO_OF	,0054385(*)	,0012992	,007	,000993	,009884

* The mean difference is significant at the .05 level.

Conclusions

This study allows us to draw the following conclusions as to the friction behaviour of the non conventional blends:

- PLA fibre has a strong influence on the friction, independently of being on the outer or in the inner face of the fabric, corresponding to a worst handle.
- PLA fibre blend with Cotton fibre as the contact material has also shown to be the one with lower amplitude value, meaning a more homogeneous surface.
- Cotton fibre as the contact material, regardless of the fabric blend. has shown to be always the highest friction coefficient, corresponding in each pair to the best handle. However, when combined with SPF fibre is when the values are higher thus corresponding to the best handle.
- The Scheffe analysis has demonstrated that there are three different subsets among the tested samples. A detailed study of the multiple comparison analysis table shows that the mean difference obtained between CO-SPF_OF and PES/CO-CO_IF is only 0,048. a value very close to the 0.05 level of significance in which the test in carried out, showing that probably this sample belongs to the last group of the CO-SPF_OF sample.

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