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A Comparison of the Key Parameters Affecting the Dynamic and Static Drape Coefficients of Natural-Fibre Woven Fabrics by a Newly Devised Dynamic Drape Automatic Measuring System

Abstract
A new dynamic drape automatic measuring system integrating Cusick's drapemeter principle with the image analysis technique was devised to automatically measure the static and dynamic drape coefficients of fabrics. The relationship for four natural-fibre woven fabrics between the fabric drape coefficient and sixteen physical properties, based on the Kawabata Evaluation System for fabrics (KES-F), were investigated. Results show that the experimental data of the dynamic drape coefficient versus the rotating speed can be well fitted to a Boltzmann function. The correlation coefficient analysis showed that the static drape coefficient and the dynamic drape coefficients of these four natural-fibre woven fabrics, at 100 and 125 r.p.m. did not have a very good correlation, apart from the wool fabric. The key parameters for the static drape coefficient and dynamic drape coefficient at 100 r.p.m. of each natural-fibre fabric were selected from sixteen physical properties using a stepwise regression method. Results showed that the selected key parameters of different natural-fibre fabrics were not entirely the same, and that the static drape coefficient of a fabric could not show dynamic performance. However, the bending and shearing blocked properties were found to be most closely associated with the static and dynamic drape coefficient for the test fabrics. The tensile, compressional, surface, and weight blocked properties were nuisance-blocked properties for the drape coefficient.

Key words: *dynamic drape automatic measuring system, dynamic drape coefficient, Boltzmann function, KES-F system, parameter selection.*

Introduction

Drape is the fabric's ability to deform in space when bent under its own weight. In 1930, Perice found that the draping quality of a fabric had a significant influence on the bending length, and developed the cantilever method for the measurement of fabric bending properties [1, 2]. Chu et al. developed the standard F.R.L. drapemeter for the measurement of three-dimensional drape [3, 4]. Cusick introduced a simple method to calculate the drape coefficient, and found that it depends on both shear stiffness and bending length [5]. He explored the correlations between the static drapability parameters of fabric, such as bending length, shear stiffness, and drape coefficient (the ratio of the projected area of the specimen's original area) [5 - 7].

In their research on the influence of bending rigidity (B) and fabric weight (W) on static drapability, Hearle and Amirbayat proposed that a more complex relationship existed between physical characteristics and drapability [8, 9]. The drape coefficient is not only related to two dimensionless energy groups J_1 and J_2, which relate to bending, membrane, and potential energies, but is also influenced by other parameters such as the full set of anisotropic in-plane membrane and out-of-plane bending and cross-term elastic constants; in addition, the nonlinearity of response may be involved [8]. Collier et al. applied stepwise multiple regression to study the relationship between the drape coefficient and six parameters, bending modulus, bending hysteresis, bending rigidity, shear stiffness, shear hysteresis at 0.5°, and shear hysteresis at 5°, and found that shear hysteresis and bending resistance were the most closely associated with fabric drape [10]. Niwa & Seto used parameters such as bending rigidity (B), bending hysteresis (2HB), weight per unit area (W), shear stiffness (G), and shear hysteresis (2HG) to find that the drape coefficient of women's dress fabrics is very much influenced by $(2HB/W)^{1/2}$ [11]. Hu et al. used the KES-F system to perform a thorough investigation of the relationships between all physical properties and static drape. They suggested that the mean deviation of the friction coefficient and the tensile linearity, in addition to the bending and shear properties, related closely to the drape coefficient of fabrics [12]. Okur & Cihan analysed the relationship between drape coefficient and mechanical properties based on the FAST system for women's woven suiting-fabrics, and suggested that there was a high correlation between drape coefficient, bending, and extension at a 45° bias angle [13].

Vangheluwe & Kiekens calculated the drape index using an image analysis technology, based on the number of pixels of the projected area of the draped fabric [14]. Wu et al. used image analysis to simulate the mechanical properties of fabric [15]. The drape characteristics of sewn knit fabrics were investigated using the image analysis by Ucar et al. [16]. Stylios & Zhu devised a Static- and Dynamic-drape-measurement System and introduced a new algorithm and a feature vector to assess fabric-drape performance [17]. Matsudaira carried out a series of studies in connection with physical properties, such as bending rigidity, bending hysteresis, weight per unit area, shear stiffness, and shear hysteresis, to investigate the static and dynamic drapability of new synthetic-fibre fabrics [18, 19].

To date, although many researchers have used the static drapemeter to study static draping behaviour, the static drape coefficient cannot show the actual dynamic real-life performance [1 - 9, 12, 15, 16]. Some studies have focused on the dynamic drapability of synthetic-fibre fabrics [18, 19]. The effect of physical properties

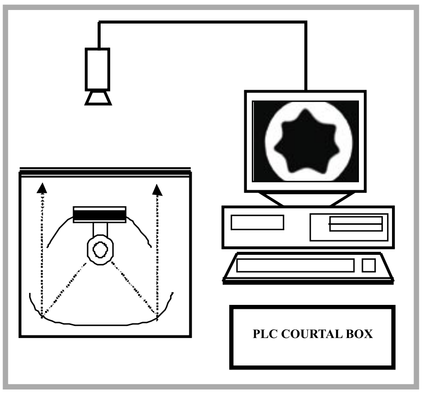

Figure 1. A schematic diagram of the Dynamic Drape Automatic Measuring System.

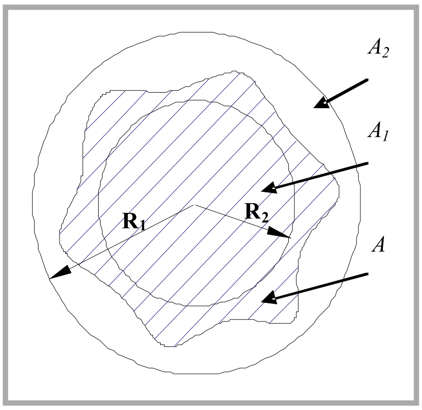

Figure 2. Definition of the fabric drape coefficient; A - actual projected area of specimen, A_1 - area of supporting disk, πR_2^2, A_2 - area of specimen, πR_1^2, R_1 = 15cm, R_2 = 9 cm, Drape coefficient = $(A - A_1)/(A_2 - A_1)$.

on the dynamic drape of natural fibre fabrics has been minimal. The purpose of the present work was to develop a Dynamic Drape Automatic Measuring System to measure the drape coefficient of a fabric. The relationship between sixteen physical properties, measured by the KES-F system, and the static and dynamic drape of four natural fibre woven fabrics, namely cotton, linen, silk, and wool, was investigated. The correlation between physical properties and dynamic drape coefficient was analysed. The key parameters for the static and dynamic drape coefficients of each natural fibre fabric were selected based on sixteen physical properties using a stepwise regression method. A comparison of the key parameters affecting dynamic and static drape coefficients of natural fibre woven fabrics using a new devised dynamic drape automatic measuring system is studied in this work. A comparison of the key parameters affecting the dynamic and static drape coefficients of natural fibre woven fabrics by a newly devised dynamic drape automatic measuring system is analysed in this work.

Experimental

Dynamic Drape Automatic Measuring System

We present herein a description of a self-devised Dynamic Drape Automatic Measuring System (DDAMS) integrating the drapemeter principle, video capture and image analysis technique, including a rotating sample table which was driven by a stepper motor. The rotating speed of the sample table can be adjusted with a programmable logic controller. A CCD camera set above the projection panel interfaced with a video board in a PC is used to record the profile created by the draped fabric. The profile is then subjected to a series of image processing steps in order to obtain a closed contour of the dynamic drape profile. The drape coefficient is obtained by calculating the number of pixels covered by the area of the drape contour. The DDAMS system is not only valid for measuring the dynamic drape coefficient, but also for measuring the static drape coefficient. The schematic diagram of the DDAMS is shown in Figure 1.

In the projection panel, a curved reflective glass is used to obtain a high level of reflectivity. The glass surface was coated with aluminium to obtain a mirror-like surface. The coating was applied very carefully to ensure a uniform reflection from the mirror at all angles, since a stable and uniform light reflected from the curved glass is required. A halogen lamp was used and centred on the mirror. To obtain a projected profile of the draped sample with an even boundary brightness, the brightness of the light can be adjusted arbitrarily.

The sample is then clamped between two circular sample discs, and the profile of the sample is captured by the CCD camera. A closed contour of the dynamic drape profile is obtained after image processing. The drape coefficient of a fabric can then be obtained by calculating the area of the drape contour. The definition of the drape coefficient of a fabric is given in Figure 2.

Experimental materials

194 pieces of four natural fibre woven fabrics, namely cotton, linen, silk, and wool, were used in this work. The quantities of each natural fibre fabric were not the same. There are 68 cotton, 24 linen, 33 silk and 69 wool fabric pieces. Three distinct areas were taken as samples for each piece of fabric. The basic properties of the samples are listed in Table 1. Sixteen physical properties of the samples, trimmed to a 20 cm × 20 cm square, were measured using a KES-F instrument. A circular sample with a 30 cm diameter was cut out for the drape measurement. The static and dynamic drape coefficients of samples were measured by a self-devised dynamic drapemeter with an automatic measuring system. All of the samples were kept for 24 hours at 20 ± 2 °C and 65 ± 2% RH prior to taking the measurements.

Key parameters selection

A correlation coefficient analysis was used to determine the relationship among the static and dynamic drape coefficients and among the sixteen physical properties, based on the KES-F system. The ANOVA analysis was used to compare the differences among physical properties of the four natural fibre fabrics. A t-test analysis was performed to evaluate the difference between the physical property of two fabrics. The key parameters, based on the sixteen physical properties, of the static and dynamic drape coefficients were selected using a stepwise regression method [20, 21]. The contribution of the selected parameters was evaluated using a partial F-test criterion method. SPSS 10 was used in the ANOVA analysis, t-test, correlation coefficient analysis, and the multiple stepwise regression.

***Table 1.** Basic properties of the sample fabrics; * Thickness is measured as being under 0.5 cN/cm², ** Total hand value (KN-301-WINDOW).*

Fabric	Cotton		Linen		Silk		Wool	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Warp density, ends/in	108.9	30.7	60.3	16.5	101.0	33.3	87.8	14.4
Weft density, picks/in	69.6	17.4	52.0	10.3	85.2	21.2	82.1	13.4
Thickness, mm*	0.53	0.10	0.65	0.14	0.38	0.14	0.52	0.08
Weight, mg/cm²	13.9	3.1	17.4	4.6	9.8	3.0	19.1	2.7
T.H.V.**	3.08	0.55	2.65	0.50	2.94	0.59	3.51	0.32

Results and discussion

The KES-F system was used to measure sixteen physical properties, which were grouped into six blocked properties, such as tensile, bending, shearing, surface, compressional, as well as thickness and weight blocked properties. The ranges and standard deviations of the sixteen physical properties of the four natural fibre fabrics are listed in Table 2. The ANOVA analysis was adopted to compare the difference among the physical properties of the four natural fibre fabrics. The analysis results showed that the difference was significant ($p < 0.001$). In addition, the t-test analysis was also used to evaluate the difference between two natural fibre fabrics. The analysis results indicated that some of the physical properties between two natural fibre fabrics had no significant difference, such as the LT value between linen and wool fabrics ($p = 0.510$, $p > 0.05$), and linen and silk fabrics ($p = 0.185$, $p > 0.05$). In comparison with the blocked property of these four natural fibre fabrics, the results showed that cotton fabric had a high shearing blocked property and a low compressional blocked property. Linen fabrics had high bending and surface blocked properties and low tensile property. Silk fabric had low tensile, bending, shearing, as well as low thickness and weight blocked properties. Wool fabrics had a high tensile blocked property and low bending and surface blocked properties. All of these properties affect the drapability of the fabrics.

A series of typical dynamic rotating profiles of the four natural fibre fabrics at speeds of 0, 50, 75, 100, and 125 r.p.m. together with their contours are shown in Figure 3 after image processing. It can be seen that the drape contours of each fabric close to a circle when the rotating speed increases. The static and dynamic drape coefficients of samples were measured by a DDAMS. The results show that the drape coefficient changes drastically with the rotating speed. The experimental data of drape coefficient and rotating speed was fitted to a Boltzmann function in the following equation:

$$Y = A_2 + (A_1 - A_2)/(1 + \exp((x - x_0)/dx))$$

where Y is the drape coefficient, A_1 is the initial value of the drape coefficient, A_2 is the final value of the drape coefficient, x is the rotating speed, x_0 is the central point of the transition (directly obtained from $f(x_0) = (A_1 + A_2)/2$), and dx deals

Table 2. *Sixteen physical properties of four natural fibre fabric groups.*

Block property	Physical property	Cotton		Linen		Silk		Wool	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Tensile	LT	0.72	0.06	0.68	0.05	0.65	0.07	0.69	0.06
	WT	10.6	2.3	12.2	3.0	7.4	2.9	13.0	2.0
	RT	44.0	4.9	38.5	7.8	55.1	8.8	60.8	4.2
Bending	B	0.068	0.041	0.141	0.065	0.052	0.030	0.074	0.020
	2HB	0.066	0.041	0.077	0.045	0.026	0.023	0.022	0.006
Shearing	G	1.29	0.62	0.42	0.32	0.23	0.13	0.54	0.13
	2HG	2.20	1.13	0.46	0.46	0.16	0.19	0.39	0.09
	2HG5	4.46	2.32	2.31	1.43	1.22	0.98	1.05	0.45
Surface	MIU	0.146	0.014	0.161	0.021	0.17	0.027	0.132	0.012
	MMD	0.020	0.011	0.031	0.010	0.017	0.009	0.014	0.003
	SMD	5.28	2.33	9.94	2.06	4.6	2.71	3.56	1.53
Compression	LC	0.316	0.029	0.323	0.052	0.41	0.089	0.328	0.033
	WC	0.167	0.040	0.203	0.061	0.11	0.054	0.121	0.028
	RC	52.2	4.7	53.4	5.0	71.2	15.5	73.7	3.3
Thickness and weight	T	0.53	0.1	0.65	0.14	0.38	0.14	0.52	0.08
	W	13.9	3.1	17.4	4.6	9.82	3.0	19.1	2.7

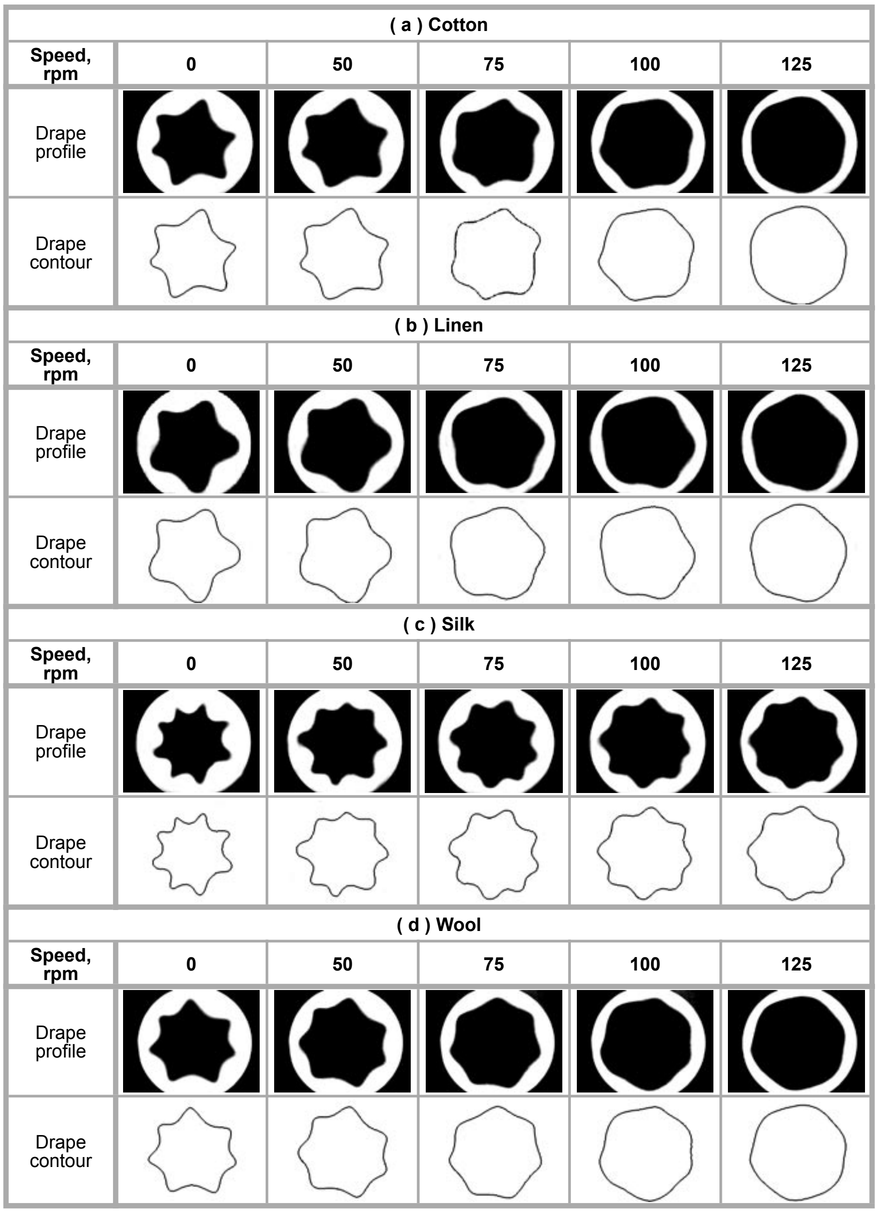

Figure 3. *Typical dynamic drape profiles and their contours after an image processing of the fabrics at rotating speeds of 0, 50, 75, 100, and 125 r.p.m.*

with the width of the transition. A Boltzmann regression analysis algorithm from the Origin 7.0 software was used. The drape coefficients of the fabrics were plotted as a Boltzmann function of the rotating speeds and are shown in Figure 4. As shown in Figure 4, all the R^2 values of the fabrics are above 0.99. The values of drape coefficient show that cotton fabric (C-DC) had the highest static drape coefficient, followed by linen (L-DC), wool (W-DC), and then silk (S-DC) fabric. This result agrees with Okur & Cihan s results, which state that fabrics that have low values of shear and the bending stiffness will have a low drape coefficient [13]. For dynamic drapability, wool fabric shows a higher incremental rate than linen fabric. The values of the drape coefficient at 125 r.p.m. show that cotton fabric still has the highest static drapability, followed by wool, linen, and then silk.

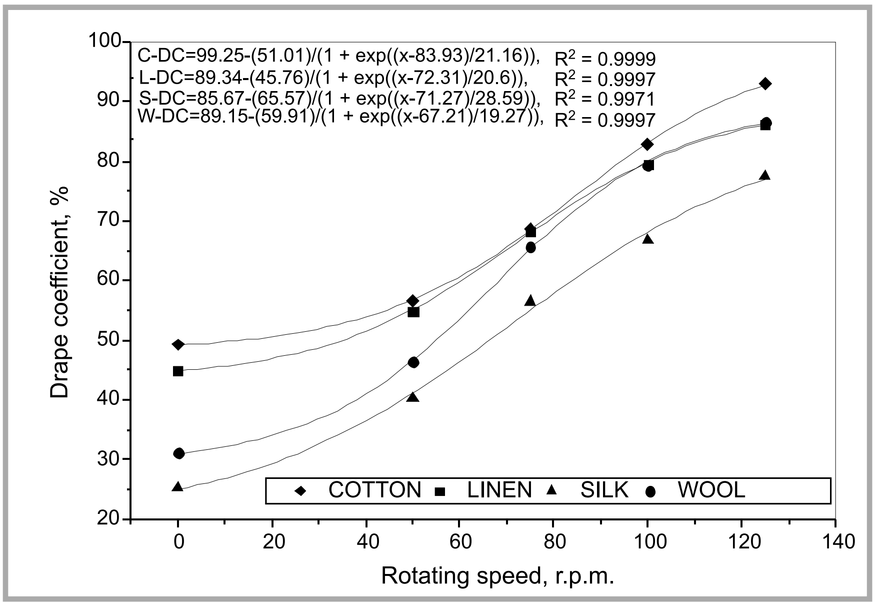

***Figure 4.** The relation of the drape coefficient to the rotating speed. Line drawn through the experimental points is a Boltzmann fit.*

The correlation coefficients of the static and the dynamic drape coefficients of fabrics were analysed and listed in Table 3. Results show that DC_0-DC_{50}, DC_0-DC_{75}, DC_{50}-DC_{75}, and DC_{100}-DC_{125} showed excellent correlation with the correlation coefficients in the 0.8 ~ 1.0 range for fabrics, with the exception for DC_{50}-DC_{75} of silk fabric at 0.661. This means that the static drape coefficient (DC_0) has excellent correlation with the drape coefficients at low rotating speeds, say, 50 and 75 r.p.m.; and the drape coefficients had excellent correlation at rotating speeds of 100 and 125 r.p.m. However, no such excellent correlation between the static drape coefficient and the drape coefficients measured at rotating speeds of 100 and 125 r.p.m. could be found, except for those with wool fabric. Therefore, for the study of the relationship between the drape coefficient and the sixteen physical properties based on the KES-F system, the drape coefficients measured at 0 and 100 r.p.m. were used as the representatives of the static and dynamic drapability respectively of a fabric.

The effect of sixteen physical properties on the static and dynamic drape coefficients of four natural fibre fabrics was analysed (see Table 4). The results show that 2HB, B, 2HG, G, W, LT, and 2HG5, with a significance level (p-value) of less than 1%, had a strong impact on the DC_0 of cotton fabric, and in that order; WC, LC, W, B, and WT strongly impacted on the DC_{100} of cotton fabric. LT, MIU, 2HB, B, RT, and 2HG5 strongly impacted on the DC_0 of linen fabric; LC, B, and MIU had a strong impact on the DC_{100} of linen fabric. 2HG5, 2HB, B, LT, 2HG, and G had a strong impact on the DC_0 of silk fabric; 2HG5, 2HB, B, and LT strongly impacted on the DC_{100} of silk fabric. 2HG5, B, and 2HB had a strong impact on the DC_0 of wool fabric; 2HB, 2HG5, and B had a strong impact on the DC_{100} of wool fabric. Regarding the six blocked properties, it is evident that the drape coefficient for these four natural fibre fabrics are strongly influenced by bending and shearing blocked properties with the exception of the shearing blocked property of cotton and linen fabrics at DC_{100}. The results conform well with the findings of Chu et al. and Cusick [3 - 7]. The other blocked properties had a somewhat weak to moderate influence on the fabrics. It is worth noting that the drape coefficient was more strongly influenced by the bending blocked property than by the shearing blocked property.

Before the parameter selection of the fabrics, the correlations of sixteen physical properties of fabrics were first analysed. It appears that some physical properties are significantly correlated

***Table 3.** Correlation coefficient analysis of the static and the dynamic drape coefficients of four natural fibre fabrics; * p-value < 0.05 ** p-value < 0.01.*

Fabric		DC_0	DC_{50}	DC_{75}	DC_{100}	DC_{125}
Cotton	DC_0	1				
	DC_{50}	0.961**	1			
	DC_{75}	0.889**	0.898**	1		
	DC_{100}	0.513**	0.568**	0.693**	1	
	DC_{125}	0.532**	0.546**	0.645**	0.860	1
Linen	DC_0	1				
	DC_{50}	0.986**	1			
	DC_{75}	0.854**	0.920**	1		
	DC_{100}	0.648**	0.681	0.754**	1	
	DC_{125}	0.601**	0.566**	0.486*	0.834**	1
Silk	DC_0	1				
	DC_{50}	0.918**	1			
	DC_{75}	0.800**	0.661**	1		
	DC_{100}	0.810**	0.598**	0.842**	1	
	DC_{125}	0.753**	0.562**	0.697**	0.933**	1
Wool	DC_0	1				
	DC_{50}	0.978**	1			
	DC_{75}	0.927**	0.962**	1		
	DC_{100}	0.880**	0.927**	0.934**	1	
	DC_{125}	0.897**	0.941**	0.958**	0.972**	1

Table 4. *Correlation coefficient analysis of the DC_0 and DC_{100} of four* natural fibre fabrics; ** p-value < 0.05, ** p-value < 0.01.*

Fabric		LT	WT	RT	B	2HB	G	2HG	2HG5	MIU	MMD	SMD	LC	WC	RC	T	W
Cotton	DC_0	0.416**	-0.130	-0.016	0.649**	0.688**	0.556**	0.592**	0.360**	-0.098	0.114	0.136	-0.168	-0.023	-0.282*	0.308*	0.534**
	DC_{100}	0.094	-0.324**	0.222	0.325**	0.240*	0.208	0.221	-0.141	-0.113	0.171	0.165	-0.395**	-0.525**	0.100	-0.054	0.338**
Linen	DC_0	0.747**	0.278	-0.549**	0.563**	0.665**	0.442*	0.428*	0.547**	-0.687**	-0.131	-0.324	-0.433*	-0.121	-0.192	-0.174	-0.019
	DC_{100}	0.408*	0.177	-0.511*	0.635**	0.441*	-0.079	-0.137	-0.056	-0.590**	-0.249	-0.310	-0.678**	-0.244	0.031	-0.215	0.019
Silk	DC_0	0.600**	-0.186	-0.222	0.654**	0.730**	0.460**	0.517**	0.782**	-0.291	0.279	-0.195	-0.040	-0.171	0.062	-0.179	-0.131
	DC_{100}	0.591**	-0.048	-0.376*	0.633**	0.671**	0.223	0.370*	0.675**	-0.080	0.330	0.034	0.069	0.001	-0.069	0.014	0.082
Wool	DC_0	0.231	-0.058	-0.194	0.415**	0.406**	0.054	-0.239*	-0.459**	-0.210	0.242*	0.209	0.005	-0.082	0.140	0.051	-0.060
	DC_{100}	0.282*	-0.107	-0.184	0.317**	0.377**	0.199	-0.051	-0.321**	-0.293*	0.225	0.057	-0.034	-0.159	0.122	-0.010	0.034

with others, meaning that these physical properties are mutually exchangeable. In the case of cotton fabric, B-2HB, B-W, G-2HG, and G-2HG5 showed excellent correlation with the correlation coefficient in the 0.8 ~ 1.0 range; WT-RT, 2HB-W, 2HG-2HG5, MMD-SMD, and WC-T showed good correlation with correlation coefficient in the range of 0.6 ~ 0.79. For linen fabric, B-2HB, G-2HG, G-2HG5, 2HG-2HG5, WC-T, and T-W showed excellent correlation; WT-RT, MIU-LC, WC-RC, and RC-T showed good correlation. For silk fabric, B-2HB, 2HG-2HG5, WC-T, and T-W showed excellent correlation; WT-RT, RT-T, G-2HG, G-2HG5, MIU-SMD, MIU-WC, MIU-T, MIU-W, SMD-WC, SMD-T, WC-RC, WC-W, RC-T, and RC-W showed good correlation. For wool fabric, B-2HB, B-W, and WC-T showed excellent correlation; LT-RT, B-T, 2HB-W, 2HG-2HG5, MIU-WC, and T-W showed good correlation. Generally speaking, B-2HB showed excellent correlation for all four natural fibre fabrics. G-2HG, G-2HG5, and 2HG-2HG5, WC-T, and T-W showed excellent to good correlation, with the exceptions for wool in G-2HG (0.533) and G-2HG5 (0.518) and for cotton in T-W (0.587). WT-RT showed negatively good correlation with the exception for wool (-0.462). These results were reflected in the parameter selection of the four natural fibre fabrics. In the related analysis described above, the correlation coefficients between the sixteen physical properties and the drape coefficients were only graded from good to poor; no excellent association (1.0 ~ 0.8) was found (see Table 4). Some physical properties with drape coefficients exhibited relativity low correlations. Some physical properties were not completely independent from one another. A forward selection of the stepwise regression method was used to determine the appropriate properties as key parameters, directly affecting the drape coefficient. The procedure for selecting and analysing each parameter of the fabrics is shown in Table 5. The entered-in and the removed-out significant levels for these parameters were 0.05 and 0.1 respectively. 2HB, 2HG, LC, LT, and 2HG5 were selected as parameters for the DC_0 of cotton fabric, and WC and B were selected as the parameters for the DC_{100} of cotton fabric. LT, 2HB, RT, and 2HG5 were selected as the parameters for the DC_0 of linen fabric; LC, B, and SMD were selected as parameters for the DC_{100} of linen fabric. 2HG5, 2HB, and MIU were selected as parameters for the DC_0 of silk fabric, and 2HG5 and B were selected as parameters for the DC_{100} of silk fabric. 2HG5, 2HB, W, B, G, and WT were selected as parameters for the DC_0 of wool fabric; 2HB, 2HG5, G, WT, and W were selected as parameters for

Table 5. *Parameter selection process; Criteria; p_{out}: 0.1, p_{in}: 0.05.*

(a) Cotton Fabric			
Cotton Fabric	Parameter	Signif.-F	R
DC_0	2HB	0.000	0.688
	2HB · 2HG	0.000	0.755
	2HB · 2HG · LC	0.000	0.801
	2HB · 2HG · LC · LT	0.000	0.816
	2HB · 2HG · LC · LT · 2HG5	0.000	0.834
DC_{100}	WC	0.000	0.525
	WC · B	0.000	0.638

(b) Linen Fabric			
Linen Fabric	Parameter	Signif.-F	R
DC_0	LT	0.000	0.747
	LT · 2HB	0.000	0.862
	LT · 2HB · RT	0.000	0.928
	LT · 2HB · RT · 2HG5	0.000	0.945
DC_{100}	LC	0.000	0.678
	LC · B	0.000	0.800
	LC · B · SMD	0.000	0.862

(c) Silk Fabric			
Silk Fabric	Parameter	Signif.-F	R
DC_0	2HG5	0.000	0.782
	2HG5 · 2HB	0.000	0.882
	2HG5 · 2HB · MIU	0.000	0.905
DC_{100}	2HG5	0.000	0.675
	2HG5 · B	0.000	0.789

(d) Wool Fabric			
Wool Fabric	Parameter	Signif.-F	R
DC_0	2HG5	0.000	0.459
	2HG5 · 2HB	0.000	0.723
	2HG5 · 2HB · W	0.000	0.787
	2HG5 · 2HB · W · B	0.000	0.845
	2HG5 · 2HB · W · B · G	0.000	0.865
	2HG5 · 2HB · W · B · G · WT	0.000	0.891
DC_{100}	2HB	0.001	0.377
	2HB · 2HG5	0.000	0.584
	2HB · 2HG5 · G	0.000	0.674
	2HB · 2HG5 · G · WT	0.000	0.733
	2HB · 2HG5 · G · WT · W	0.000	0.756

the DC_{100} of wool fabric. The R value is higher than 0.638. Although 2HG-2HG5 in cotton and W-B and 2HB-W in wool showed good to excellent correlation, 2HG in cotton and W and 2HB in wool were selected first, and then 2HG5 in cotton B and W in wool were selected as appropriate parameters. This is because the remaining physical properties are considered and determined at the next selecting stage, which provides most of the additional information about drape coefficient. When comparing the effects of sixteen physical properties on the drape coefficients of the four natural fibre fabrics, it is evident that most of the selected parameters are those that have a strong impact on the physical properties of the four natural fibre fabrics. Most of these selected parameters are included in both bending and shearing blocked properties. Although the selected parameters for the four natural fibre fabrics are different, the bending blocked property was selected by all fabrics as an important blocked property. The tensile, compressional, surface, and weight-blocked properties are nuisance-blocked properties for the drape coefficient of fabrics.

Conclusions

A new dynamic drapemeter with an automatic measuring system was successfully devised for measuring the static and dynamic drape coefficients of fabrics. Five rotating speeds, 0 (static), 50, 75, 100, and 125 r.p.m., were used in this research. Experimental data of drape coefficient versus rotating speed can be well fitted to a Boltzmann function. The values of drape coefficient show that cotton and linen fabrics have a higher static drapability. On the other hand, wool fabrics show a higher incremental rate of drape coefficient as the rotating speed increased; the drape coefficient of wool fabric was higher than that of linen fabric at 125 r.p.m. The values of the drape coefficients at 125 r.p.m. in descending order were cotton, wool, linen, and silk fabric. It was also found that the static drape coefficient and the dynamic drape coefficients measured at the rotating speeds of 50 and 75 r.p.m. had excellent correlation. The dynamic drape coefficients at 100 and 125 r.p.m. had excellent correlation as well. However, the excellent correlation between the static drape coefficient and the dynamic drape coefficients at 100 and 125 r.p.m. was not found, except for that with the wool fabric. The static drape coefficient of a fabric cannot show any dynamic performance.

An analysis of the effect of sixteen physical properties, which are grouped into six blocked properties based on the KES-F instrument on the drape coefficient of the fabrics, found that these four natural fibre fabrics were strongly influenced by bending and shearing blocked properties, with the exception of the shearing blocked property for cotton and linen fabrics at DC_{100}. The other blocked properties had a somewhat weak to moderate influence on the fabrics. The results conformed to the key parameters selection. The selected parameters for each kind of fabric are not entirely the same. It was also found that, in general, bending and shearing blocked properties were selected as two important blocked properties for the static and dynamic drape coefficients of fabrics. In addition, tensile, compressional, surface, and weight blocked properties appear to be nuisance-blocked properties for the drape coefficient of fabrics. These results coincided with the analysis of the effect of sixteen physical properties on the drape coefficients of these four natural fibre fabrics.

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